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THE BIOLOGIC ORIGIN OF MENTAL VARIETY, OR HOW WE CAME TO HAVE MINDS.[1]

BY HERBERT NICHOLS.

It is not an infrequent combination that the most familiar things neither excite curiosity nor are understood. Our subtitle suggests an instance of this kind. The naive man commonly takes for granted that he sees the landscape, and hears the orchestra, for no further reason than that they are there before him to be seen and heard. A man a degree wiser gets so far as to recognize that eyes, ears and a brain are necessary. If a biologist be asked, to-day, how we came by this apparatus, he will answer, "through evolution." This is the maximum reach of Science at present. Yet it is nearly as naive to conceive that we have minds, such as ours, merely because we have eyes, ears and a brain, as for one to imagine that he sees just because he has his eyes open. This becomes apparent if we consider the widely accepted doctrine that all the sensory currents running through the nerves to the brain are of the same general sort, as much so as those in electric wires

[1] This paper, under the title "Psychology and Biology" and now somewhat altered from the original, was one of six lectures on "Modern Psychology and its Bearings," delivered, by the author, at Johns Hopkins University in March, 1896.

some of which ring bells while others blow whistles. For if it be asked why our sensory currents 'ring up' such different results as sight from the optic nerve, and hearing from the auditory nerve, it is plainly not satisfactory to answer, "because we have eyes and ears," if, as this doctrine asserts, the eye and ear nerve currents are alike. Nor is it much more enlightening to be told that "it is the *place* in the cortex to which the different nerves run that makes the difference in the sensation resulting from them;" not unless we are in some way told wherein and why these "places" differ. It is just in the fact of never having even inquired how these "places" came to differ, that our evolutionary science falls short in one of the most curiously interesting and important questions that can arise either in biology or in psychology.

Of course, it is a fundamental assumption of both these sciences that all our mental differences are paralleled by molecular differences among the neural activities that underlie them. But this still avoids the question why these last are different, and how they came to be so. And until some answer shall be found that shall logically connect these ultimate neural peculiarities with those peculiarities in outer objects which the world commonly conceives to correspond to our various sights and sounds, it can scarcely be boasted that we are much less naive than the ancients who thought that the objects gave off films that floated into our minds bodily. I by no means imply that this doctrine of all sensory nerve currents being of the same sort is universally accepted. But where any other hypothesis has been offered in its place, the relationship between inner sense and outer stimulus has been left as barren of explanation as even in this doctrine, where, apparently, the possibility of explanation is cut off altogether. But all these matters we are to examine categorically further on. Sufficient has now been said, by way of introduction, to make clear that it is the *variety* of our sensory responses (without which our minds would not be minds), and of their connection with the sorts of stimuli with which they are now connected, that we are, in this paper, to subject to careful investigation. It should be obvious that this inquiry must in-

volve, fundamentally, the evolutionary relation between biology and psychology; and it is for this reason that I have selected it as worthy of the present occasion.

Plunging at once to the heart of our problem, I may state that there are two possible propositions regarding the fundamental relation of our senses to their respective sense organs; which propositions are mutually contradictory and exclusive of each other; which, being fundamental and contradictory, it is necessary to decide between, as a first step toward any permanent insight into the evolutionary relation between body and mind; yet regarding which neither science nor philosophy, up to the present moment, has given any least intimation. It will be the main purpose of this paper to set forth these alternative postulates as completely as I may, within the limit of an hour; and if within that space we do not arrive at any vantage ground, where we may venture a guess at the proper decision between them, I trust that this will but the more emphasize their vast and crucial significance. To venture a prophecy, I may state that the indispensible solution of these two postulates is not likely to be reached for many years to come, nor until wider discussions and further reaching investigations shall have been ploughed under them, than now cover the fields of the great Weissman-Lamarck controversy.

The first of these postulates may be stated as follows: In the light of the little knowledge we as yet possess, it is open to conceive that, in the beginning of the present epoch of animal evolution, crude or primary protoplasm was sensitive not only to all the forms of physical stimulation which now produce sensory responses in us (i. e., sight, sound, taste, smell, touch, temperature, muscle, and other sensations), but was also capable, in response to appropriate stimuli, of an infinite, or x number of other forms of sensation which we know nothing about. In accord, and in illustration of this possibility, we may conceive that the simplest amorphous creatures now actually experience an infinite variety of transient and elementary sensations, including the few we have and a multitude of others that we never have.

Under this conception, we may look upon the rise and development of sense organs generally to mean the slow differentiation of protoplasm to the exclusive use of certain specific forms of stimulation. Thus we may interpret the appearance of eyes to mean the production of an apparatus peculiarly adapted for light waves to the exclusion of all other forms of stimuli. Through the appropriation of the entire fixed surface of our bodies to the particular sense organs which developed in our ancestry, we see how, under this proposition, our few kinds of sense should have been *preserved* to us ; and how the infinite number of others with which it endows primitive protoplasm, *should be lost to us through the required forms of stimulation being shut out.*

The alternative of this fundamental formula is that we may conceive, quite oppositely, that protoplasm was capable at first of only one form of sensory response ; and of but one mode of neuro-sensory activity correspondent therewith. What this form of sense was we need not consider, at present, further than to suspect that it may have been far different from anything we experience.

Under this proposition we should attribute the rise of various new senses to the development of new kinds of protoplasm, capable of correspondently new forms of sensation. Thus the advent of sight and of sight organs, here, would mean the development of a new basis of physical activities, peculiarly susceptible to light stimulation, and the psychic counterpart of which would be a new kind of sense.

These, then, are our opposing hypotheses. According to one, *Life began with many fleeting, transitory senses, and we have become shut in to a few permanent and highly developed ones.* According to the other, *Life began with one simple sense, and has opened outward with the development of our various and complicated senses.*

It will now be proper to bring forward the implications of these great rival theories in a way to justify the lofty prospectus which we have announced for them.

First we should note, as already has been intimated, that both propositions, alike fundamentally, assume different phases

of neural activity for every psychic happening or sensation, and for every sense quality and shade of quality. That is, one sort for red, another for blue, and others for every sort of taste, smell, and so on.

Next we may note that both propositions equally involve the fact that physical activities immediately underlying our psychic states are enormously complex. Demonstrably, by modern experimentation, they rest upon a chemical basis, intricate beyond all comparison; each molecule comprising various atomic components which, in number, according to highest authority, mount among the billions, and out-run all adequate comprehension.[2]

Next we may observe that in proportion as these molecular activities are complex, so will the molecular differences be great which correspondently lie *between* our different elementary sensations, that is, which correspond to the psychic differences between sights, sounds, smells, tastes and our other major classifications of sensory elements; and between the reds, blues and greens, sweets, sours and bitters, and other minor differences observable in each subclassification, down to the limits of their infinity.

Of course, the old doctrine of specific energies, handed down to us by Johannes Müller, taught us to expect that every different quality of sense must be paralleled by a different form of neural activity. But by emphasizing the enormous complexity of these neural forms, and the vast molecular differences between them, which must be implied by the differences to be observed among our several senses, I wish to bring forward what appears to me to be one of the most important truths in mental science, and one which, in so far as I know, has never before been caught sight of, or taken into account in deciphering the great problem of mind and body.

For finally we may observe that, *Intrinsically and within themselves, these molecular differences, correspondent to the differences among our psychic elements, must necessarily have constituted determining factors of animal evolution; and must have decided what peculiar psychic elements should be selected, and perman-*

[2] See "Man's Glassy Essence," by Charles Pearce, in *The Monist*, October, 1891.

ently incorporated into our psychic existence. They must, therefore, explain the variety of our psychic elements, and the origin of their connection with the central mechanisms on which they now depend, and with their respective sense organs. Consequently, also, they must furnish a key for deciding between our two rival theories of the origin of our psycho-physical organism. And altogether, a study of this subject must unlock to us wide and unforseen fields of scientific truths.

That the evolutionary values of his various "energies" should not have been perceived by Müller is not surprising, but that they remain unconsidered to-day can only be explained by the vagueness of current notions regarding them; and it must now be our task to come to a realization of the conditions which they involve.

Bearing in mind that, as is now demonstrable, the molecular basis underlying each one of the sense-elements of which our brain is capable comprises billions of variable physical constituents, we may first note that this truth must have its influence within the sphere of *Spontaneous Variation.* We do not yet fully know the laws which govern variation, and there is difference of opinion as to the role it plays in developing organisms. But at least the followers of Weissmann should appreciate that not all neural "energies" of such vast complexity could have equal chances of advent, and that this fact must have been a major condition in the origin of those different classes of sensation with which we are now equipped.

Secondly, we may appreciate that the variants in question must constitute determining factors of organization within the circle of *Nutrition.* Not only must our intricate brain components be born into our organism, but they must be maintained there in face of exhaustion and fatigue. Loss of the thyroid gland demonstrates to-day how special are the ingredients necessary for maintaining the general functions of intelligence; and there is ample room within the mysteries of Aphasia to suspect that the requirements are even yet more specific that must be provided within localized regions of the cortex for our different senses. Every notion of modern science suggests that these activities must be specifically com-

plex and vastly variable, and assuming them to be so, the conclusion is inevitable that they should neither be produced or maintained with equal ease; and that, therefore, within the course of adaptation and survival their specific characteristics must have determined, respectively, their own advent and perpetuation.

Third comes the vast region of fitness and selection, which must rise from the relative serviceableness of these several complex activities to *The Environmental Forces,* to whose stimulation they must join themselves for the creature's welfare and preservation. That this sphere is likely to prove of central interest in our problem should be obvious, and because we are to give it much attention further on, we may limit ourselves to the bare statement of it here.

A fourth region of evolutionary choice among possible sense energies must be found in the relative adaptiveness of their molecular complexities to the development and perfection of such peripheral or end-apparatus processes as are requisite or of profit for mediating between them and the environmental forces. Within this field, more than anywhere else, perhaps, we are likely to discover the functions which most intimately determine the diverse forms of our perceptive organs, and that fix thereby the sorts of mental pictures dependent thereon. This, also, we are to discuss with some fulness presently.

Finally, the factors in question must have determinative bearings within our general physiology. These it will be necessary and important for Science in time to work out; but they are of a nature so remote from psychologic problems proper that they need not be intruded further upon the limited space of this present paper.

Their self-determinative fate within the realms of their Zoologic Genesis, their Physiologic Maintenance and Organization, and their Environmental Adaptation, these, then, are what we have chiefly to study, in our present quest. And these lines being laid down, the following considerations pertinently thrust themselves forward, for our further guidance. It should be obvious at the outset that the nervous currents or impulses

passing from the periphery to the cortex, and arousing there the activities lying nearest to the final sensory results, should be of crucial importance in our investigation of the molecular differences assumed to underly our different senses. Regarding these nerve currents two main opinions are held. Professor Wundt conceives that all the sensory cortical cells are equally potent of all the different sense-forms at our birth; and that the sort of response they actually give is dependent on the form of the impulse that reaches them through the peripheral nerves to which they happen anatomically to be joined.

According to an opposite view, advocated by Prof. James and many others, and to which in our introduction we have already made allusion, the currents in the different sensory nerves are all alike, and the sort of sensory responses they mediate are wholly dependent on the respective places in the cortex to which the different nerves run. The fundamental fact being, that each center is congenitally destined to its one specific form of activity, and the different centers to their permanently different forms.

We can get a sharp notion of these opposing views, as the text-books commonly point out, by imagining the visual and the auditory nerves to be cut somewhere in their course, and the cut ends to be crossed and joined together again so that thereafter the visual impulses will reach the auditory center, and the auditory impulses the visual center. Under this new condition, according to Prof. Wundt, we should both hear and see precisely as before; because both of these cortical centers are capable of both results; because what happens depends on the different forms of the currents that are determined in the peripheral sense organs; and because these run through unchanged, in spite of the crossing and that they are carried to new places. But, according to Prof. James' view, where the currents in the different nerves are all alike, and the results depend wholly on the place in the cortex in which they arrive—under the crossed conditions one should now "see the thunder and hear the lightning."

The chief facts on which the latter notion is founded is, that while the sensory nerves generally are sensitive to several

kinds of artificial stimulation, the sensation resulting thereby is always the same for each nerve. For example, the cut stump of the optic nerve will respond to pinching, pricking, burning, and to chemical and electric stimulation; but always with an indefinite visual flash, whatever the form of stimulus that is applied.

The chief facts upon which those who agree with Prof. Wundt base their opinion, are summed up within certain alleged phenomena of "Substitution," there being some reason to believe that when parts of the cortex are destroyed, either by disease or by experimentation upon animals, certain remaining parts take upon themselves the former functions of the lost parts, and change their former habits and modes of response in so doing.

Neither of these opposing theories are conclusively substantiated at present, since there are counter replies for each. Thus it is open for Prof. Wundt to explain the fact of the optic nerve replying invariably with sight sensations to every sort of artificial stimulation, by saying that this is only true in the adult, where the cells, by having only one form of stimulation brought to them by the nerve to which they are permanently fixed, have been educated persistently in one form of response past the age when they have lost the power of plasticity and of shaking off the old habit to take on a new one—a power which at birth they eminently possessed. And, on the other side, it is open for those who believe in fixed congenital responses to suspect that all the facts of Substitution are due to the lost function being taken up by remaining cells of the same kind, and especially by the correspondent cells of the other half of the body; *i. e.*, those of like kind in the opposite lobe of the brain.

Such is the state of this controversy up to date; and its confusion would be out of place in our present study if we were not now able both to bring this problem, by new considerations, to a solution, and also to demonstrate its cogent bearings upon our main subject. We speedily come to this by recalling that we have already determined that the molecular differences, corresponding to the differences between our several senses, are

certain to have been determining factors of the evolutionary relationship between our minds and bodies in any case, and by then passing on to observe that the sphere of this relationship would be vastly different respectively under our two rival theories regarding afferent nerve currents. Indeed, would be so different as to demand consequences, under one of these theories, so incompatible with existing facts that we shall be able to discard that theory altogether, thus reducing our difficulties, and giving us in the remaining theory an invaluable guide for our main investigation.

This difference in evolutionary sphere comes to view the moment we recognize that under the Wundtian notion (of the sensory currents being different all the way through the nerves to the periphery and to the different environmental forces which respectively stimulate them) the forces determining the selection and perpetuation of these currents in the organism would include all the five regions in which we discovered it was possible for our "molecular differences" (specific energies) to work with selective or evolutionary fitness—namely, the regions of Spontaneous Variation, of Nutrition, of Environmental Adaptiveness, of End-Organ Adaptiveness, and the vaguer sphere of our general physiology. On the other hand, and under the notion that the afferent currents are all alike, it should be plain that this likeness would cut off our central processes, regardless of their molecular differences, from all relative serviceableness either to the great world of environmental forces or to the intricate and indispensable mediating processes in the end-organs, and would thus reduce the sphere of their evolutionary reciprocity to the three remaining and apparently lesser fields.

The significance of this is so great that we shall do well to set forth the connection between our senses and their stimuli, under this point of view, by an illustration. We may do this by imagining two wires coming to this desk, one of which is attached to a bell that is rung in accord with the velocity of the wind outside by an electric current, brought through a wire from a proper apparatus on the roof—a heavy wind ringing the bell violently, and a calm giving no ring at all—and

the other wire we will imagine to be connected with a visible index, the rise and fall of which is determined by the rise and fall of a barometer and other electric apparatus, also situate on the roof. Under this illustration the ringing of the sonorous bell and the moving of the visible index are the analogues of our sensations, the electric wires correspond with our nerves, the wind-gauge and barometer with our end-organs, and the wind and temperature with their external stimuli. And since, under these conditions, by merely changing the wires here at the desk and connecting the barometer with the bell, and the wind-gauge with the index, the "sensory" results would be completely reversed from what they formerly were, so, therefore, we have here a perfect example of what Prof. James means, by saying that all depends on the *place* in the cortex with which the currents or wires are connected. And, going now a step further, these conditions also illustrate what Prof. James has wholly neglected to consider, namely, the evolutionary influences which *made* the "places" in our cortex different, and those which first connected them with the particular end-organs and stimuli with which they are now permanently connected; and these, we quickly perceive, are the important points in our great main problem. Precisely what we want to know is how we came to have the variety of senses that we do have, and how they came to be joined to the particular stimuli to which they are joined. From time out of mind mankind has naively taken for granted that the now existing relationship between sensations and their stimuli is an eternally permanent one of immediate cause and effect. But, as we have pointed out, this cannot be the case if the currents in all the sensory nerves are alike, and if, as Prof. James contends, it is alone the "place" in the cortex which determines the sort of sensation that shall respond to any sort of current or stimulus which may run to it. In this case it should be plain that it is in the characteristic differences of these "places" and in the evolutionary origin of the same, and of their permanent connection with their present peripheral organs, that the secrets must lie which we are in search of. Surely no one, under the conditions of our illustration, would

investigate alone the wind and temperature apparatus on the roof in order to discover why we hear the bell ring instead of see the index move. But, rather he would extend his investigations to discovering how the " nerve " connections originated that now exist, and how the internal apparatus, to which they run, came to be so different that in one case we " see " and in the other " hear " from the same sort of incoming current.

Enabled by this illustration to look with greater clearness into Prof. James' hypothesis, and into some of its implications, we may now go back to the assertions that vastly different spheres of evolutionary influence would be involved as between this theory that these currents are alike and the rival theory that they are different, and to the assertion that certain consequences are logically demanded by the " alike " theory which are so contrary to existing facts that it must be discarded.

What has been neglected by Prof. James is, as I have said, the *evolutionary or selective value* of the sensory currents. If these currents were all alike, then, manifestly the molecular differences which we are obliged to assume in the cortex as underlying our different sensations would be cut off from all diversity of influence either from the end-organ processes or from the environmental forces. *And this is the same as saying that they would be cut off from all selective relationship with these great spheres of influence, and that our end-organs and environment had nothing whatever to do with the origin of our different senses.*

Now, it must not be too quickly inferred from these words in italics, that it would be impossible to account for the evolutionary selection of our several senses within the narrowed sphere of influences remaining after cutting off the peripheral and outer forces. Such an inference would not only be wrong but also would confuse and obscure certain considerations that we are to come to further on, and in view of which it is imperative for me to stop long enough here to point out that the sphere of Spontaneous Variation alone *might* be sufficient to account for the variety of our senses and their present external connections, if *only their origin and not their preservation* needed to be accounted for. And this is done in pointing out that these connections might be originally due wholly to the

period at which a spontaneous variation made a new kind of "sense energy" possible. Thus, the present connection of cerebral sight with the optic nerve and with the eyes, and with the light that falls on them, might well, for all we know to the contrary, be entirely due to the chance appearance of a new form of "energy" or molecular possibility in the cortex just at a time when the development of optic end-organs made a connection with the new cerebral development available, and the exigences of the outer environment made the new linkage of processes of service. Such a connection of inner sense to outer stimulus would be as accidental as anything can be, yet it might be adequate for explaining the facts of our problem *were no influences to be considered that might disturb the permanency of such connections.* And this brings us finally to the influences which most surely would have disturbed the permanency which actually has been maintained, had this theory that the sensory nerve currents are alike been really in force.

These disturbing influences become apparent when we consider the uniformity of the functions that would be left to central nervous processes under the conditions of this theory. No one has ever contended that the outgoing currents of the motor nerves are of diverse kinds. If, therefore, the incoming currents were also all alike, there would then be left to the central processes the entirely homogeneous switch-board function of connecting like currents with like currents. And, under such conditions, and cut off from all diversity of external influences, it seems scarcely possible that some one form of molecular activity or "sense energy" out of the many that variation may have given birth to or protoplasm been originally capable of, would not prove most suitable to this one purpose, and as a consequence become perpetuated to the exclusion of all other less suitable kinds of neural sense-forms. Or, put again more simply, *since molecular forms are sure to have been evolutionary determinants, therefore, if all the nerve currents were alike it seems certain that the cortical processes must also have become alike.* And since this manifestly is not the case, therefore we must abandon Prof. James' theory.

(*To be Continued.*)

PINEY BRANCH (D. C.) QUARRY WORKSHOP AND ITS IMPLEMENTS.[1]

BY THOMAS WILSON.[2]

(Continued from page 885.)

II.

Mr. Holmes' paper comprises 26 printed pages. The first part is occupied with a description and statement of facts; the second part is as I have shown made up of theory, assumption, opinion. I have examined them sufficiently to show their want of value. But the climax is reserved to the closing portion, for, commencing on page 19 and continuing 8 pages is a chapter relating to the age of the workshop and the race of the men who worked it. Mr. Holmes' conclusion is that though the quarry is prehistoric the age is not great and the race was the Modern Indian. This he argues with profundity, going into the racial question in detail and with great elaboration.

I decline to argue these propositions. I am appalled at the temerity as well as the dogmatism with which he decides these abstruse questions. He is a gentleman for whom I have the highest regard. I have known him well and favorably for many years. He has studied and written upon art products and art evolution and their relation with prehistoric man, in a philosophical and artistic strain which has done credit to his logic, and been as much benefit to art as to archæology. But Sir John Lubbock, Sir John Evans, Prof. Tylor, Sophus Müller, Hildebrand, Montellius, Naidallac, Hamy, de Mortillet and Cartailhac and the host of eminent Europeans, archæologists and anthropologists, of whom Keane is the latest author, who have spent their lives in the study of this science,

[1] Read before the Anthropological Society, Tuesday Evening, December 4, 1894.

[2] Curator of Prehistoric Anthropology, U. S. National Museum, Washington, D. C.

have not ventured upon the determination of these questions of prehistoric ages and races. with the confidence of Mr. Holmes, and certainly they do not decide these important questions with even a fraction of the satisfaction and certainty which seems to have inspired him.

Mr. Holmes did not content himself with the things of today which he saw in the quarry, but turned his mind's eye back when the quarry was being made and depicts it in the time of antiquity, with apparently as much certainty as if he had been then and there present. He not only describes the work with the detail and positiveness I have shown, telling the periods to which it belonged and the race and culture of the men who did the work, but he assumes to decide upon the objects *not* there. He determines not only upon what was left in the quarry, but he decides with equal positiveness upon the ultimate purpose and intention of the workman and the future use and destination of the implements which had been transported elsewhere.

He describes in several places the leaf-shaped blade—the "third stage" of his process—straight and symmetrical, with edges as slightly beveled as consistent with strength, less than half an inch in thickness and shown in *i* to *p*, Pl. IV (my Pl. XIX), and says "when they were realized, the work of this shop was ended" (XX), "they, and they only, were carried away to destinies we may yet reveal" (p. 13). "No examples of the successful quarry products were left upon the ground" (p. 15). "All forms available for further shaping or immediate use were carried away as being the entire product of the shop * * * for final finishing" (p. 15). "This was a stage of advancement which made them portable and placed them fully within reach of processes to be employed in finishing, and that they had been carried away to the villages and buried in damp earth (*cached*), that they might not become hard and (or) brittle before the time came for flaking them into the forms required in the arts. The history of the quarry forms is not completed, however, until we have noted their *final distribution among the individuals of the various tribes,* until we have witnessed the *final step* in the *shaping process*—the flaking out of specific

forms with a tool of bone—and their *final adaptation to use* and *dispersal over the country*," (p. 18).

"Having reached a definite conclusion that the blades were the *exclusively worked product* of the quarry," he "was led to investigate their subsequent history" (p. 18). The italics are mine. His investigation into the subsequent history of these objects led him to define a *cache*. "A 'cache' is a cluster or hoard of stone implements, numbering, perhaps, a score or more, secreted or deposited in the earth and never exhumed. Such hoards are frequently discovered by workmen in the fields," (p. 18).

Pursuing the "subsequent history" of these implements, I propose to go into the region round about Piney Branch, examine the aboriginal village sites of the District of Columbia, the fields containing these alleged secret hoards or caches, and the known places of aboriginal occupation within the neighborhood where these implements were said to have been carried, and see what have actually been found there, what of caches, what of leaf-shaped blades, and what of implements which had been subjected to the (fourth or other) "processes to be employed in finishing, when they were flaked into the final forms required in the arts" (p. 18), and I propose we compare the the objects actually found in these distant places, with what Mr. Holmes said would be found.

I look through my Department in the National Museum for the leaf-shaped implements which, according to the theory of Mr. Holmes, were made at Piney Branch and carried out to the homes of the Indians, their makers, in the District of Columbia, and I find the numbers insignificant; while, as to caches, the Bureau of Ethnology, through Prof. Cyrus Thomas, has lately made a catalogue of the "Known Prehistoric Works in the Eastern United States," among them deposits, hoards, or caches, and there is not a single cache reported from the District of Columbia, this, despite the statement of Mr. Holmes that "such hoards are frequently discovered by workmen in the field."

In the settlement of these questions, it is of high importance that so far as possible, facts and not guesses should be given.

I have taken the trouble to segregate the specimens in my Department in regard to material and locality and to ask a similar report from such private collectors as I could reach. The results I have given in the form of tables, and I have attempted in these to draw a sharp line between the implements which might, according to the Mr. Holmes' theory, have come from Piney Branch quarry, and those which did not.

No implement of *quartz,* found here or elsewhere came from the Piney Branch quarry, nor any of felsite or rhyolite, nor of argillite, shale or ferruginous sandstone, nor of flint, chert, or jasper; for Piney Branch was a quarry of quartzite only.

The following tables show the Aboriginal chipped stone implements from the District of Columbia and its neighborhood, divided according to material, form, locality, and mode of deposit, so as to show the number of quartzite leaf-shaped blades which might have come from Piney Branch quarry, according to Mr. Holmes' theory, and to compare them with those differing in these conditions, and thereby show what number did not come from Piney Branch.

TABLE I. CACHES, HOARDS OR DEPOSITS OF LEAF-SHAPED BLADES. ARRANGED ACCORDING TO LOCALITY AND MATERIAL.

Locality.	Quartz.		Quartzite.		Porphyritic felsite, Rhyolite.		Argillite shale, Fer. Sandstone.		Flint. Jasper. Chert.		[Totals.]	
	Caches.	No. of Implts.	Caches.	No. of Implts.	Caches.	No. of Implts.	Caches.	No. of Implts.	Caches.	No. of Implts.	Caches.	No. of Implts.
Bennings			1	7								
Red Bank			1	5							2	12
Jones Landing												
Piney Branch												
Little Falls					1	a8					1	8
Anacostia												
Pierce's Mills					1	a32					1	32
Piscataway, Md			1	b500							1	500
					1	25					1	25
					1	25					1	25
					1	26					1	26
South River, Ann Arundel Co., Maryland							1	114			1	114
South River, Ann Arundel Co., Md									1	7	1	7
									1	4	1	4
South River, Ann Arundel Co., Md												
Glenely												
Howard County					1	b100					1	100
Clarksville, Howard County					1	52					1	52
			3	512	7	268	1	114	2	11	13	905

a, not leaf-shaped; b, estimated.

There have been found in the District (Table I) but two caches of quartzite, containing together only 12 leaf-shaped blades. These are according to Mr. Holmes' theory, "the entire product of the shops" (p. 15), which "had been carried away to the villages and buried in the damp earth (cached) that they might not become too hard and (or) brittle." This was a sorry product of so extensive a quarry as Piney Branch with the "500,000 pieces of waste and failures" found therein by Mr. Holmes; and must have been a sore disappointment to even the cynical and thriftless Indian.

Plate XXIII represents 20 specimens of a cache of 32 arrow or spear heads and leaf-shaped implements found near Pierce's Mill, Rock Creek. Most of the specimens are broken. They are of porphyritic felsite and, therefore, never had any relation with the quartzite quarry at Piney Branch.

Should it be urged that some of the leaf-shaped blades may not have been cached or, if so, that the caches had been disturbed and the blades scattered over the surface, I have made a schedule of these, (table II), which shows a total of 1,948 leaf-shaped blades found on the surface, not cached, of which 1,065 were of quartz, felsite, argillite, etc., and but 883 of quartzite. It

TABLE II. LEAFED-SHAPED BLADES—*NOT* CACHED.

Locality.	Quartz.	Quartzite.	Porphyritic felsite, Rhyolite.	Argillite, Shale, Fer. Sandstone.	Flint. Jasper. Chert.
	No. of Implts.	No. of Implts.	No. of Implts.	No. of Implts.	No. of Implts,
Bennings	4	300	100	100	
	2	30	2	2	1
Red Bank		100	100	40	
Jones Landing		50	20	10	
Piney Branch		15			
		17			
Little Falls	1	215	308	202	
Anacostia	2				
Pierce's Mill					
Cabin John		22	6		1
Piscataway					
U. S. Natl. Mus. Miscl. Collections, from D. C., generally.	148	134	5	10	1
.	157	883	541	364	3

Total implements, quartzite, ...883
Total implements not quartzite, ...1065

1,948

is a part of Mr. Holmes' theory that "the working of such a quarry led *inevitably* to the production of blades *in numbers* (meaning in great numbers), and it follows that they were removed "in numbers" (p. 18), but my examination demonstrates the error of this theory, for it shows the blades of quartzite (which alone could have been carried from Piney Branch Quarry) to be in the minority.

Again, Mr. Holmes theorizes (p. 18) that a "time came for flaking them (the blades) into the final forms, knife-blades, scrapers, perforators, and arrow and spear points required in the arts." Therefore, I made still another table (III) to show any of these final forms which might possibly have been made *from leaf-shaped blades;* and, again, we find the theory not

TABLE III. ARROW AND SPEAR HEADS WHICH MIGHT HAVE BEEN MADE FROM LEAF-SHAPED BLADES.

Locality.	Quartz.	Quartzite.	Porphyritic felsite, Rhyolite.	Argillite, Clay slate. iron stone.	Jasper. Chert.
	No. of Implts.	No. of Implts.	No. of Implts.	No. of Implts.	No of Implts.
Bennings	15	15	7	2	
	300	100	50	25	
		2			
Red Bank	200	75	300	50	
Jones Landing	100	50	50	25	
Piney Branch					
Anacostia		2			
Little Falls	102	200	304	50	
Falls Church, Va.,		37	1	8	
		4	1		
Piscataway	3				
U. S. Natl. Mus. Mis. Collec-					8
tions, from D. C., generaliy.	149	209	15	73	2
	869	664	728	223	10

Total implements, quartzite, ...694
Total implements not quartzite, ...1840

2534

borne out by facts, for of all these leaf-shaped forms, numbering 2,634, only 694 were of quartzite and could have come from Piney Branch quarry. Thus, it appears that of the leaf-shaped blades found in the District and its environments, cached or not cached, the greater number have been of other material than quartzite, and must have come from other localities than Piney Branch quarry. Is not all this cumulative evidence of error somewhere in Mr. Holmes' theory?

There have been caches found adjacent in Maryland, and it may be suggested that these implements from Piney Branch might have been carried beyond the boundaries of the District of Columbia. But, unfortunately for this theory, the implements which have been found *en cache* in Maryland and adjacent to the District of Columbia are of porphyritic felsite, argillite, and other different material from those in the quarry at Piney Branch, and thus totally dissimilar from them. J. D. McGuire, Esq., of Ellicott City, Md., has furnished the best Maryland collection of these implements known (Table I) and he has kindly furnished me a sample series which have been photographed and are shown in Plate XXIV.

They show 8 caches—one of them 100 and one 114 specimens and a total of 365 specimens, not one of which could possibly have come from Piney Branch for one cache is of flint and jasper specimens, and one of argillite (similar to the leaf-shaped blades found by Dr. Abbot at Trenton), and six are porphyritic felsite or rhyolite.

The leaf-shaped implements found *en cache* in Maryland and some parts of Pennsylvania are, I believe, mostly either of argillite or porphyritic felsite. Several of these caches from the respective localities are to be seen in the Museum, and a single glance is sufficient to establish the absence of their relationship with the quartzite from Piney Branch.

We have now sought for the Piney Branch leaf-shaped quartzite blades at the home of the Indian, throughout the Districs of Columbia and the adjacent parts of Maryland where, according to Mr. Holmes, they were "buried in the damp earth;" andwe have sought in vain. Caches of such implements are not found within the District nor in its neighborhood. It may be hardy to declare a negative and to say that because these quartzite implements have not been found that they do not exist; but how much more hardy and, indeed, perilous must it be for Mr. Holmes to risk everything by declaring the existence of these caches when they have never been found.

The story told by the tables is not completed. Table IV tells of the "flaked implements, knife-blades, scrapers, arrow and spear points and perforators" (which Mr. Holmes says

were common to the region), which were not from the Piney Branch quarry because not made of quartzite. This table shows 21497 such specimens. Table III, showed 2,534 specimens which might have been made from leaf-shaped blades,

TABLE IV. OTHER IMPLEMENTS, SUCH AS KNIVES, SCRAPERS, PERFORATORS, ARROW AND SPEAR HEADS, ETC., APPARENTLY *NOT* MADE FROM LEAF-SHAPED BLADES

Locality.	Quartz.	Quartzite.	Porphritic Felsite, Rhyolite.	Argillite, Clay. slate, Iron stone.	Flint. Jasper. Chert.
	No. of Implts.	No. of Implts.	No. of Implts.	No. of Implts.	No. of Implts.
Bennings	716	260	13	350	
	3000	4000	200	1500	
Red Bank	700	1200	1500	500	
Jones Landing	300	500	200	100	
Anacostia	35				
Piney Branch					
Little Falls	28	12	23	26	
	500	1000	2000	100	
Pierce's Mill			32		
Piscataway	25	75			
Falls Church	8	6		1	
U. S. Natl. Mus. Miscl. Collec-			3987		12
tions. from D. C., generally.	1720	554	19	253	29
	7032	7607	3955	2830	41

Total implements *not* made from leaf-shaped blades 21,497

Recapitulation.

Table I. Leaf-shaped blades, *cached* 865
Table II. Leaf-shaped blades, *not cached*, ... 1,948
Table III. Leaf-shaped blades, Impls. made from, ... 2,534
Table IV. Impls. *not* made from leaf-shaped blades, ... 21,497

26,844

but of these, only 694 were of quartzite. The aggregate of these counts shows 24,031 (21,497 + 2, 534) specimens in these collections not made from Piney Branch quartzite leaf-shaped blades, against 694 which might have been.

Plate XXV shows how arrow and spear heads are, or may be, made from leaf-shaped implements. The five specimens at the top of the Plate are such. They were at one time leaf-shaped implements, and by the making of the notch and stem, they have been changed to arrow or spear heads, that is to say, they have been subjected to the second process which has changed them "into the final forms re-

quired by the arts" (p. 18). The four specimens at the bottom are leaf-shaped blades of quartzite found on the surface at Bennings, D. C., and might or might not have been the product of the quarry at Piney Branch. They form part of the 330 in Table II from that locality. Those in the middle are also leaf-shaped, found on the surface in the District or adjoining it in Maryland or Virginia, but are of quartz, argillite, shale, porphyritic felsite, all of them other material than quartzite, and so they could not have been the product of the quarry at Piney Branch. They form part of 541 in Table II and of the 1948 in Table V.

TABLE V. RECAPITULATION ACCORDING TO FORM.

	No. of Implts.	No. of Implts.	Implts. of quartzite, possibly from Piney Branch.
I.			
Caches, leaf-shaped,............................	865	865	a
Caches, not leaf-shaped,.......................	40		12
II.			
Leaf-shaped blades. Surface, not cached,		1,948	883
III.			
Arrow and spear heads, etc., flaked implements which, from their form, might have been made from leaf-shaped blades,..................................		2,534	694
IV.			
Flaked implements, knife blades, scrapers, arrow and spear points, perforators which were judged, from their form and material, were not made from leaf-shaped blades of quartzite,		21,465	1,589—Total which (according to Mr. Holmes' theory) might have been made in or come from the quarry at Piney Branch, out of a total 26,812.
	Total, all kinds,	26,812	

a. This omits the 500 from Piscataway because it is so far distant from Piney Branch and because we have no report of other implements from that locality. This cache was reported by Mr. Reynolds, who had but a single implement, given him by the finder, as a specimen.

In considering these tables and their bearirg on the Piney Branch Quarry, we are to keep continually in mind that the sole and only material in that quarry was quartzite. There was no quartz pophyritic felsite, rhyolite, shale, ferruginous sandstone, flint, jasper or chert found in any of its deposits, and all implements made from any of these materials are to be excluded from consideration because impossible to have come from that quarry. Keeping this in view, these tables show

the following state of facts: Among all those implements from the District of Columbia, but two caches of quartzite were found containing together only 12 leaf-shaped blades of 1.948 leaf-shaped blades not cached, only 883 were of quartzite; of 2,534 common implements, such as arrow- and spear-heads etc., which from their form might have been made from leaf-shaped blades, only 694 were of quartzite, making a total of 1.589 quartzite implements which, according to Mr. Holmes' theory, *might* have come from the Piney Branch Quarry, out of a total of 25,815 implements examined.

Out of all the "1,000 turtle-backs" (p. 14) gathered by Mr. Holmes, their "500,000 brothers and sisters' (p. 12) left, and the "millions of worked stone and unshaped fragments" (p. 7), all "refuse" (p. 12), "waste, failures" (p. 14), of which "these quarries on Rock Creek are the main source," all being done to produce these leaf-shaped blades to be carried away and buried (cached) in the damp earth "that they might be preserved to be made into the final forms required by the arts" (p. 18).—Out of all this toil, the result found up to date is but 2 caches with 12 blades. "The mountain was in labor," etc., etc. Out of a total of 26,812 implements reported in the collections mentioned, but 1,589 were of quartzite leaf-shaped blades that *could have come* from the Piney Branch quarry. Yet the leaf-shaped blades were, according to Mr. Holmes, the "entire product of the quarry" (pp. 13 and 15). What a deal of sack for a pennyworth of bread.

Mr. Holmes' theory that the leaf-shaped blade was the sole product of the quarry workshop, to be afterwards "flaked into the final form" of the common implements of the region, be correct, then the problem may be stated according to the arithmetical law of proportion, as follows: If 1,589 leaf-shaped *quartzite* blades, cached and not cached, finished and unfinished, have been produced from Indian toil and exertion in making the "500,000 turtle-backs," and the "million of worked stones which now occupy the site" (p. 7), all of which are wastes and failures; then how much toil and exertion, and how many millions of worked stones, wastes and failures,

would be required to produce the 26,812 specimens reported in the collections mentioned? I have inveighed against the speculation by which we sometimes attempt to determine, what a great amount of labor the Indian would do for the accomplishment of so little, sometimes the reverse; but we may fairly assume that the aborigine was not such a consummate idiot as to open a quarry as large as this at Piney Branch, and do as much hard work as must have been done there, with the paltry outcome of the insignificant number of quartzite implements shown in the aggregate collections form the District of Columbia. To complete the information on this branch, I have introduced the consolidated tables VI and VII showing the subdivisions according to material and locality.

TABLE VI. RECAPITULATION ACCORDING TO MATERIAL.

Quartz	8,058
Quartzite	9,674
Porphyritic felsite, rhyolite	5,478
Argillite, shale, fer. sandstone	3,541
Chert, flint, jasper	64
	26,815

TABLE VII. RECAPITULATION ACCORDING TO LOCALITY,

Bennings	11,108
Red Bank	4,765
Jones Landing	1,405
Piney Branch[1]	32
Little Falls Church Branch	5,071
Pierce's Mill	32
Anacostia	39
Piscataway, Md	603
Falls Church	66
Mr. McGuire's 8 caches from Md	353
District of Columbia, Museum Collection, locality unidentified	3,341
	26,815

1 Mr. Holmes' oblects are not included.

III.

Mr. Holmes' theory is that the sole implement sought to be obtained by the workman from this quarry, was the thin, leaf-shaped blade, the result of what he calls the third process. His processes Nos. 1 and 2 for making turtle-backs were according to his theory, only designed to lead up to process No. 3, which should produce the thin, leaf-shaped implement.

I think this conclusion does not accord with the facts. Whatever may have been the intention of the workman in making the single or the double turtle-back by processes 1 and 2, (figs. 1, 2, p. 878,) I feel constrained to believe that these were not stages in the production of leaf-shaped implements. I see no evidence of it. I know of no reason why the aboriginal man might not as well have been making the turtle-back for its own sake. It is found all over the United States, it corresponds in a remarkable degree with prehistoric implements from all parts of the world, and no reason is given why it should not have been as much an implement as were the leaf-shaped blades. I do not believe it possible, by any process suggested by Mr. Holmes, nor by the methods apparent from the examination of the leaf-shaped implements themselves, that they were made from the double turtle-back. Mr. Holmes himself is hazy and uncertain about his third process. It consisted, he says, p. 12, " in going over both sides a second and, perhaps, a third time, securing, by the use of small hammers and by deft and careful blows upon the edges, a rude and symmetrical blade." This might mean chipping, or it might mean pecking, hammering or battering. But the process of pecking, hammering or battering is an abrasion by which the substance is worn away grain by grain, passing off in dust; and we know that the leaf-shaped implements were all made by chipping or flaking, and not by pecking, hammering or battering.

I think I may defy Mr. Holmes to make the double turtle-back into a leaf-shaped implement by the process of chipping without treating it as an natural unworked stone and splitting it down through its center regardless of the edge which had been before made, thus destroying its edge and with it the implement. In this operation, the double turtle-back has no advantage over a natural pebble, and it must be treated as such. The operation of striking the turtle-back on the edge to split it and thereby reduce its thickness, has the effect of reducing its size correspondingly. It will have to be reduced considerably when made from the natural pebble, but it will be subjected to a double reduction in size when made from the

turtle-back. The turtle-back and the leaf-shaped implement are practically the same size, except the latter is only $\frac{3}{8}$ or $\frac{1}{2}$ inches in thickness. This reduction in thickness cannot be done without striking the turtle-back on its edge (Plate XXVI) thus working its total destruction and treating it as if it were an original pebble. The plate will make this apparent.

This argument demonstrates that the pretended evolutionary series of Mr. Holmes set forth in his Plate IV, (My Plate XIX) is incorrect. While all the implements are there truly represented, yet they do not form a continuous series. The leaf-shaped implements in the bottom row, "3rd stage, both sides re-worked," could not be made from the "turtle backs" in the two upper rows. Therefore, I deny Mr. Holmes' fundamental proposition. I am fully persuaded that the maker of these implements, whatever else he intended to do, did not intend or attempt to make the leaf-shaped blades out of the turtle-back, or at least that turtle-backs were not a stage in the process of making leaf-shaped implements. If my proposition in this regard be true it breaks Mr. Holmes' theory in the middle.

IV.

Mr. Holmes Says, p. 17, "that to a limited extent, the rude forms—the turtle-back and its near relation—are also found widely scattered over the Potomac Valley outside of the shops on the hills." The suggestion is that these came from this quarry or from similar quarries, and he charges flat-footed that they were the "rejects," "refuse," "debris," "failures."

In January, 1888, the Smithsonian Institution issued a circular, No. 36, asking of its correspondents throughout the United States and Canada, for information as to the number of these implements in their respective localities. This was accompanied with elaborate description and many illustrations, so there should be no mistake in their identity. Answers were then received, from every state in the United States and some from Canada. A consolidation of these answers, with briefs, was published in the Annual Report of the U. S. National Museum for 1888, pp. 766–702, wherein the number reported up to that time is stated at 8,502. This has been largely in-

creased since, and if now subjected to actual count, would be multiplied many times. Many of the specimens, those of quartz and quartzite or other refractory material, were rude like those from Piney Branch, Holmes' Pl. IV (Pl. XIX), but those made of flint or other homogeneous material which chipped easily, were smooth and clean, and on comparison with paleolithic implements from Europe could scarcely be distinguished; those from Texas and Utah especially so.

Bearing on this question, I chose 72 specimens out of some hundreds of the "double turtle-backs," as Mr. Holmes calls them, collected by Mr. Wm. Hunter from the neighborhood of Mt. Vernon, Va., and have had them photographed and made into a Plate XXVII. The specimens on this plate could be duplicated from almost any state. A comparison will show that the same implements are found in every state in the United States. The hammer-stone in the center happens to have been from Piney Branch. The introduction of this is to show that "the double turtle-backs" are found elsewhere than at Piney Branch in considerable numbers; that they are not isolated and sporadic, and that they are shapely and regular, even when made from the refractory quartzite, so much so as to demonstrate them to have been intentional and not accidental forms, and were neither "rejects," "refuse," nor "failures."

V.

Mr. Holmes refuses to consider the implements as furnishing any evidence of their own antiquity. He refuses to compare them with European or other known paleolithic implements, or to accept them as paleolithic because of any similarity of form, appearance, or mode of manufacture. I agree that all existing evidence should be presented and I suppose this has been done in the present case. Accepting this proposition only for the sake of this argument, my reply is that he then has no evidence of antiquity of any portion of the quarry.

Mr. Holmes contends that this great quarry, nigh a quarter of a mile square, had been dug over and excavated, (as is shown by the section, his Plate I), to an average depth of six feet and in many places to eight and nine feet, along the entire hillside

and around its point. He contends that every cubic foot of this section had been dug over, in places to the bed rock, and the stones and clay handled and worked. All the boulders and earth had been loosened and shovelled, and the entire mass re-deposited by the diggers, as the work progressed. Mr. Holmes not only admits this anterior disturbance, but claims it as giving the chief importance to his discovery. His Plate III, a photograph of the quarry face, is introduced by him to demonstrate this prior excavation.

But all this has naught to do in showing the antiquity of the quarry. If he refuses consideration and comparison of the implements and objects found therein, there is nothing to show that all this excavation, trench making and stone breaking may not have been done in comparatively modern times. There is nothing to indicate its antiquity unless it be the appearance of the surface, and this is only by the thickness of soil and the size of the trees; and both of these may have been, the latter must have been, commenced since the early part of this century.

If these trenches, of such length, depth and extent, had been dug by the modern Indian, as declared by Mr. Holmes, we can scarcely imagine that it would have been filled up, raked down, and smoothed over to a regular slope as it now is and was when the trees began to grow on it. Mr. Holmes' Plate I shows the regularity of this slope correctly. Where Mr. Holmes' greatest trenches were dug, the slope from the top of the hill to the bottom is regular and true without any ridge or hollow to indicate an open trench or pit left by the Indian who is alleged to have made it. By whomsoever that quarry was opened and whoever dug those trenches, they were afterward filled up and smoothed over, leaving no break or depression affecting the regularity of the outline of the hill-side. Our knowledge of the modern Indian teaches us that he would not perform this, to him, useless labor. This profound disturbance (the French call it *remaniement*) of the bowlders, clay and earth of the section, leaves no stratification and destroys all evidences of the age of the deposit. There is no fauna.

This, with the item just mentioned, leaves us without evidence as to the antiquity of the quarry work except as furnished by the implements themselves. Their rejection as evidence would leave the question of its antiquity unanswered, and would render the quarry of slight archaeological value. If Mr. Holmes had found stone axes, hatchets or gouges, spear or arrow heads, pieces of pipes, or fragments of pottery, these would have served as evidence of Indian origin, but the utter absence of any of these leaves the Indian theory unsupported; It is a canon of prehistoric archæology, verified by every worker in the field, that no such extensive work as claimed for this quarry could have been done by prehistoric man without having left some of his tools, implements or utensils. But here not an implement or weapon fragment of polished or smoothed stone, not an arrow or spear head, nor pottery, was found. Mr. Holmes says (p. 13), "Only one was found * * * (with) a rude stem worked out at the broad end. This specimen was found near the surface. Two other pieces found at considerable depth exhibit slight indication of specialization of form, which, however, might have been accidental." And this was all.

If it be said that this was a quarry for bowlders with which to make these implements, and that their finding in the disturbed and disarranged deposits is evidence of this fact, I reply, that the surface of the neighborhood is covered with the same kind of bowlders and many of the same kind of implements, and there is no more evidence to show that the implements were made in the quarry than there is that they were made on the surface. For anything shown in the quarry, the whole batch of turtle-backs, double and single, flaked stones, waste, debris, etc., etc., might have been originally on the surface, made there, possibly, in times of antiquity and been tumbled into the ditch, whenever it was filled up.

VI.

Mr. Holmes' paper is radical and final. He not only determines every proposition presented by the implements found at Piney Branch, but he determines them finally, and further

discussion is useless. According to him, we know (from his investigation) all about these implements, all about the man who made them, the race to which he belonged, his use of tools, his machinery and mode of manufacture, his transportation, and a large suggestion concerning his culture. If his conclusion be correct, then Mr. Holmes has determined the entire history of this man as well as that of the implements themselves. His statement is no longer a theory, it is a demonstrated proposition, a proved problem, the work is finished and the book is sealed. It is submitted that this is a greivous mistake.

VII.

I do not attempt any argument to account for this quarry or to explain either the manufacture or use of its implements. It is not my discovery, and I am in no wise bound to sustain or uphold it.

In the discussion, I have said no word about Paleolithic man in America. That question is not involved here. I have elsewhere set forth my opinion on that subject, and I may enlarge upon it on some other occasion, but not here or now.

I have sought only to criticise the theories of Mr. Holmes in reference to the quarry and its implements, and to show what I deem to be the errors in his conclusions, and in doing so I have avoided personalities. I have indulged in no maligning or abusive words, have conceded to him the most honorable intentions, and a truthful rendering of all his facts; and professing for him the kindest and most friendly feeling, I assert that in what I have said, I have given my own fair, and, as far as possible, unbiased opinion and judgment, being moved thereto solely in the interest of truth and science.

FOSSILS AND FOSSILIZATION.

By L. P. Gratacap.

II.

(*Continued from page 912*).

The replacing and mineralizing influence of surface waters may preserve bones which would otherwise quickly disappear. At Big Bone Lick in Kentucky the great numbers of bones of the buffalo are found according to Prof. Shaler " near the present position of the springs and never at any depth beneath the surface." These bones are in some places " massed to the depth of two feet or more, as close as the stones of a pavement, and so beaten down by the succeeding herds as to make it difficult to lift them from their bed." The attraction of this locality for the herds of wild animals spread through the forests of Kentucky in plistocene and recent times, arose from the saline encrustations made by the natural brines which spring to the surface at this point. There is an ossuary of their remains, the mastodon and elephant bones being upon the higher levels and the buffalo skeletons placed more within the swampy basin, which has itself undergone denudation since the advent of the great proboscideans. These bones are impregnated with salt[1] and have become partially mineralized, while the salt solution itself neutralizes any vegetable acids arising from the decomposition of the reeds which, according to Mr. Cooper, accompany the bones. Yet the falling into swamps or bogs of the great mammals and their gradual submersion and burial in the deeper layers of the tenacious and yielding mixture, has been a means of preserving their remains, especially, as besides their partial immunity from the action of organic acids, their great bones have formed, from their formidable size and texture, an irreducible nucleus. But

[1] The preservation of the bones of the Megalonyx in the Big Bone cave in Tennessee, may be partially ascribed to the presence of large quantities of saltpeter earth.

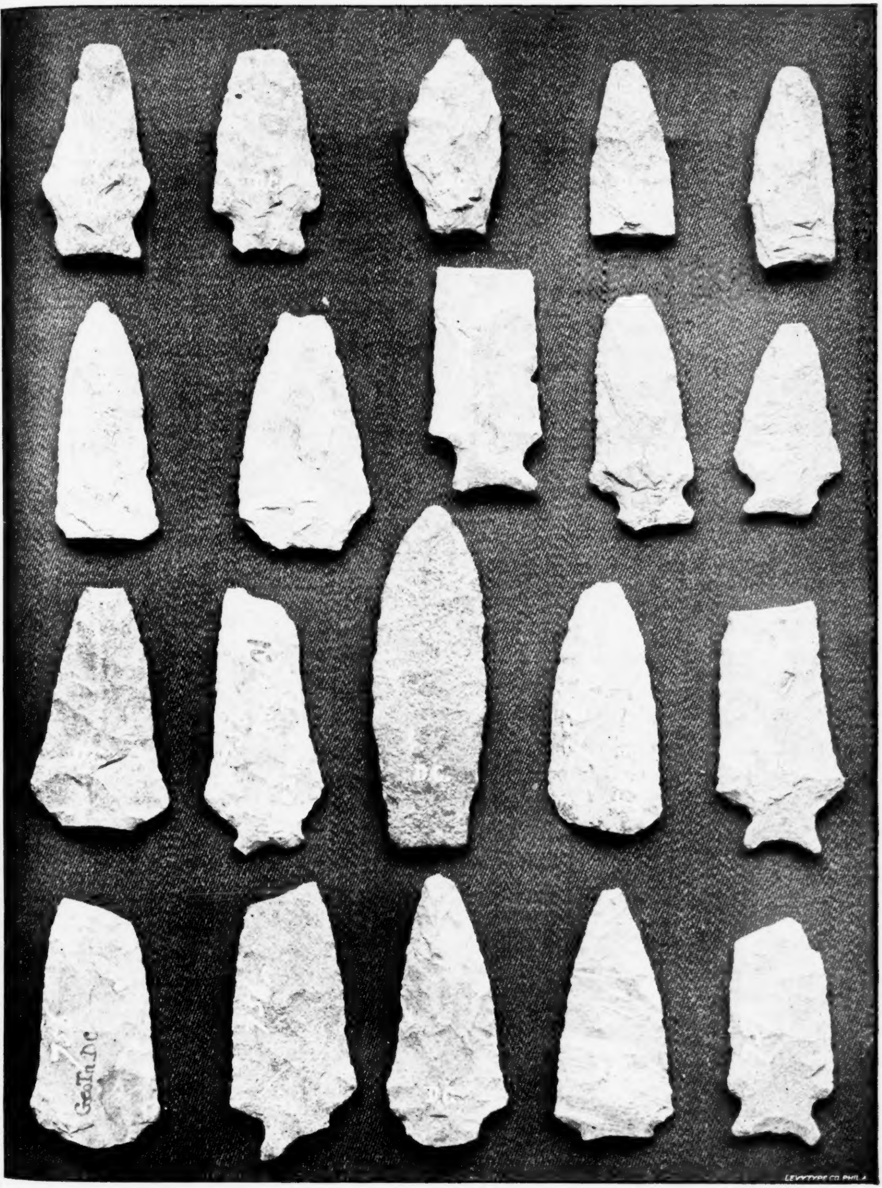
when we reinvest this continent with herds of wild animals, gregarious in habit, and probably reaching a great numerical aggregate, it seems at first singular that their entire skeletons should be so infrequent. The Mastodon, the Elephant, the Musk Ox,[2] the Caribou Moose[3], and the Reindeer, Horse, Buffalo and Mylodon have been distributed in plistocene and recent times as far south as Kentucky, yet except under peculiar circumstances of sepulture, their remains have disappeared. The conclusion is irresistible that the placement of the bones of vertebrates upon the surface of the ground is unfavorable to fossilization, that they must be covered in by deposits, and while thus held together become hermetically sealed against the accidents of surface conditions and the solution by carbonated and acid waters. The rhinoceros and elephant which were disappearing from Sumatra at the time of Mr. Wallace's visit had, after so recent a withdrawal, left few traces more than crania, tusks and teeth. Prof. Nordenskiold speaking of the polar regions pertinently remarks, " the Polar bear and the reindeer are found there in hundreds, the seal, walrus and white whale in thousands, and birds in millions. These animals must die a ' natural ' death in untold numbers. What becomes of their bodies? Of this we have for the present no idea."

The isolated death of individuals from packs of wild animals or the death of those less social in instinct, does not, under most circumstances, insure preservation. When some spot chosen for its proximity to water, or because of its fertility and nourishing vegetation, becomes a rendezvous of groups of animals, the herbivores being followed by the beasts of prey, and the region thus frequented is so situated as to receive the

[2] The Musk Ox, *Ovibos cavifrons* Leidy, was found in Loess of Iowa at Council Bluffs, twelve feet below the surface; also at Ft. Gibson, I. T., St. Louis, New Madrid, Mo., Ohio, Big Bone Lick, Ky. These specimens afforded little else than the head, separated vertebræ and leg bones.

[3] Bones of the fossil elk or moose have been found at Big Bone Lick, Kentucky, but it was reserved for Prof. W. B. Scott, of Princeton College, N. J., to obtain the magnificent example of *Cervalces americanus* Harlan now exhibited in the cabinet of that institution. This almost complete skeleton of a very large extinct elk or moose was discovered in a *shell marl deposit uuder a bog* at Mt. Hermon, N. J. (See Proc. Acad. Nat. Sci. Phila., 1885, p. 181).

PLATE XXIII.



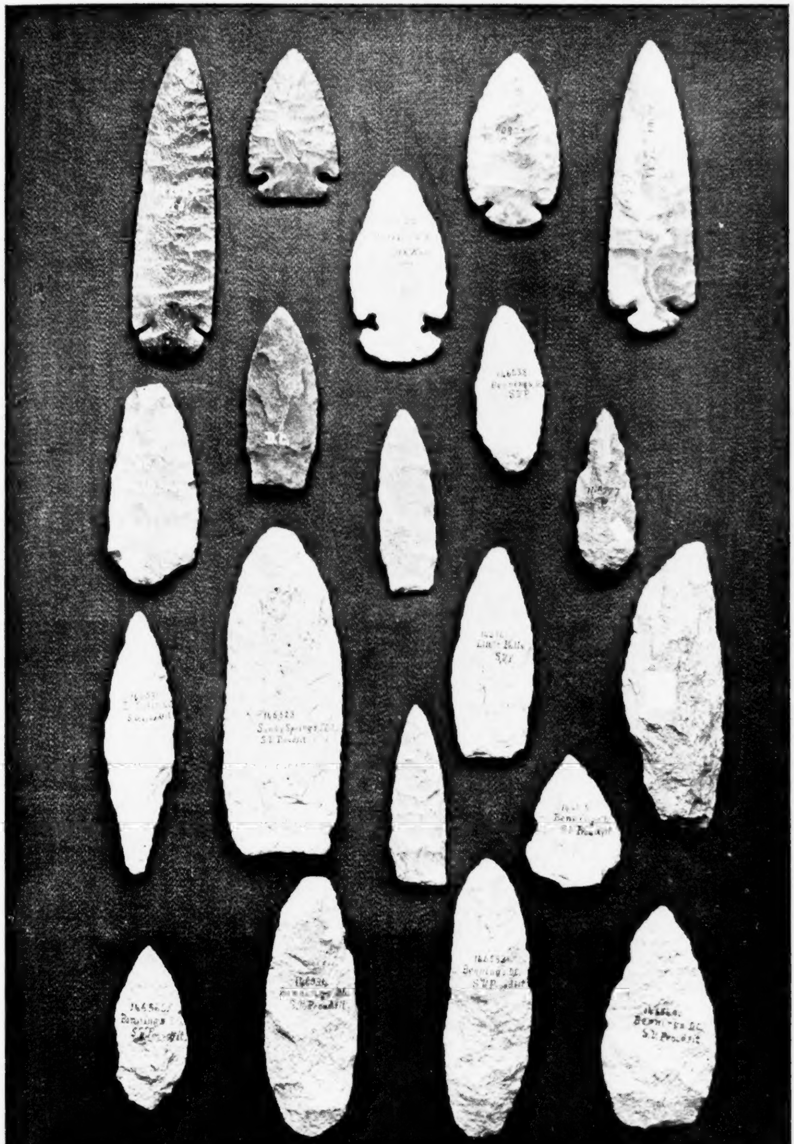
Specimens from a cache found near Pierce's Mill, Rock Creek, D. C. Porphyritic felsite.

Rep

PLATE XXIV.

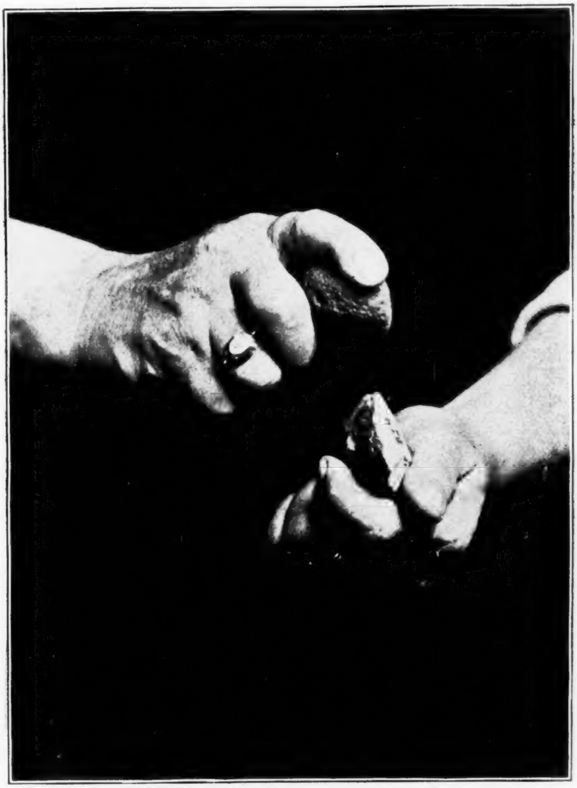
Representatives of eight caches of leaf-shaped implements found in Maryland. None quartzite.

PLATE XXV.



How some leaf-shaped implements are made into "final forms," and some not.

PLATE XXVI.



Leaf-shaped implements cannot be made from "turtle backs" without first destroying them.

PLATE XXVII.

Double "turtle backs" of quartzite found at Mt. Vernon, Va. Samples of thousands, not from Piney Branch Quarry.

drainage of the higher land, a combination of conditions is provided by which a varied fauna may secure an approximately complete representation in fossils. Such localities as those described by Captain Johnston in his Nyassaland are suggested. He says: "At the close of the dry season when the tall grass has been burnt down and there is little or no cover for the game to hide in, it is really a remarkable spectacle as seen from the deck of a steamer, to watch the great herds of big animals wandering over these savannahs in search of the young verdure springing up amid the charred stubble of the old grass.[4] With an opera glass you may distinguish water-buck, gnu, buffalo, eland, pallah, reed-buck and zebra, and occasionally some dark blue-gray blobs, much larger than the other specks and forms which are in their vicinity, turn out to be elephants." Again he says "game in the shape of antelopes and buffaloes was evidently abundant, and no doubt was attracted to the vicinity of this brackish pool by the flakes of salt which remained on the soil when the water had evaporated; and the game in its turn was followed by hyenas, lions and vultures."[5]

In geological time such localities would have afforded a rich commixture of fossil remains if the circumstances favorable for the deposition of a protecting stratum of earth existed. Yet in all instances the social relations of the animals have an importance, and those social relations are somewhat modified by the topography of the country they inhabit. The wide plains of south-eastern or subcentral Africa, with an unchecked communication for miles, numerous rivers and rich vegetation,

[4] Such scenes described by Capt. Johnston are closely imitated in the picture, drawn by W. Boyd Dawkins, of the Bristol Channel in plistocene times, when it was a fertile plain "supporting herds of reindeer, horses and bisons, many elephants and rhinoceroses, and now and then being traversed by a stray hippopotamus, which would afford abundant prey to the lions, bears and hyenas inhabiting all the accessible caves, as well as to their enemy and destroyer, man." See also Dr. E. Holub's "Seven Years in S. Africa," Vol. I, p. 267.

[5] See also East Africa and its Big Game by Sir John C. Willoughby, wherein he describes the open plain with buffalo, zebra, hartebeest, eland, rhinoceros, ostrich, Grant's antelope.s teinbock and wart-hog scattered over it, and in another place where he saw "lions, rhinoceros, lesser kudu, wild dogs, hyenas, cheetah, water-buck and zebra, the total seen amounting to nineteen varieties."

permit a most heterogeneous assemblage of animals, whereas a disturbed and mountainous country divided into lofty plateaux, low savannahs and barricaded valleys would separate and isolate related groups, and from a low zoic maxima,[6] in consequence of its irregularity and limited geographical scope, afford a meagre and less diversified fauna, and actually fewer fossils. The successful fossilization of the bones of terrestrial vertebrates can best be secured by their rapid burial within impervious beds of enveloping material wherein they undergo a slow process of partial or complete petrifaction. Nordenskiold in his Voyage of the Vega discovered a very extensive deposit of whale bones in a sand dune upon a beach of Siberia in the Chuckchi country. These apparently had fallen to the bottom of a sea and were entombed by new layers and beds of sand. They were thus subfossil and possessed an immense age. Where they had become exposed by the violence of the waves they were decaying, but where buried in the sand the well preserved bones of these cetaceans were found in innumerable quantities.

The dispersal of bones in the ocean seems as unfavorable to their preservation as exposure on the surface of the earth or in the vegetable acids of its superficial covering. It is notorious that the dredging expeditions deputed to explore the depths of the oceans have seldom encountered the remains of vertebrate animals. The skeletons of whales, seals, porpoises and sharks have not been found commonly, though teeth brought up from these depths indicate the dissolution of the animals in the oceanic waters. So striking is this absence of osseous remains that Lyell remarks "there are regions at present, in the Indian and Pacific Oceans, coextensive in area with Europe and North America where we might dredge the bottom and draw up thousands of shells and corals without obtaining one bone of a land quadruped."[7]

[6] See Amer. Nat., Vol. XX, p. 1009.

[7] "Some astonishment was created on board the 'Challenger' that the dredge after having dragged over miles and miles of the bottom of the sea, and up and down almost every oceanic basin, should never bring up any bones of fish or whale, or any remains of other large animals which inhabit the sea or whose bodies may have been carried down to the sea." Thalassa, J. J. Wild, p. 133.

The explanation of this fact has hardly advanced further than the theoretical stage. It may be attributed to the dissolving agency of carbonic anhydride in the lower strata of water, to the insidious action of the products of organic change, which Julien seems inclined to exaggerate, or to the more ordinary factors of animal consumption. Prof. Verrill and Mr. Sanderson Smith hold that the disappearance of bone in the ocean is due to its being attacked and eaten by crustacea.[8] If this is true and solution has no practical bearing as an agent in their disappearance, it seems likely that some maceration and softening produced by pressure and soakage reduce the bone to such a consistency as to render it more easily attacked by these animals, and incidentally render the bones themselves liable to separation and absorption by the sea waters. It is peculiar that while great numbers of shells are raised from the bottom of the ocean, the same areas seldom or never produce mammalian relics, the otoliths or ear bones of whales, and the teeth of sharks excepted. The skeletons of sharks and fishes might naturally undergo softening or become from their semicartilaginous nature the prey of smaller animals, but the hard parts of whales seem well calculated to resist attack. These larger animals upon their death may be dragged by submarine currents into the deeper parts of the ocean and there become subjected to a stronger chemical action than is observable at less depths. The theory of Mr. Murray as to the formation of coral reefs would make it appear that bottom waters contain more carbonic acid than those on the surface, but this Prof. Dittmar[9] calls in question, thinking that solution is effected by the prolonged contact with the sea water itself. At any rate "the alkalinity of bottom waters was

[8] It is a matter of some interest to learn that "remains of the Atlantic Walrus in a fossil state, have been found at various points along the Atlantic Coast from Maine to South Carolina, and in Europe as far south as England and France" (J. A. Allen). The most striking instance is that of a skull found on the sea beach at Long Branch, New Jersey, of which Dr. Leidy said it "has lost a porsion of the cranium proper, and the exserted portion of one tusk, but otherwise, except being a little water worn, is in a good state of preservation."

[9] The Physics and Chemistry of the voyage of H. M. S. Challenger, Vol. I, pt. 1, Composition of Ocean Water by Prof. W. Dittmar.

found to be distinctly greater than that of those from the surface, and this increase was exactly proportional to the larger quantity of lime present in the former," and upon this fact we might found a belief that bones disappeared through solution. At considerable depths pressure would greatly reinforce chemical action, and as carbonic anhydride is liquified under a pressure of something over 38 atmospheres, in the deeper basins of the ocean this reagent may exist as a liquid. In a French experiment, water, taken from a great depth of ocean, was under so high a tension from the enclosed gas, that upon release it spurted in a jet from the containing vessel.

The remains of terrestrial vertebrates represent most generally the submergence and death of the living animals themselves, and Lyell has well described the way. He says (Principles, (Vol. II, p. 542), "river inundations recur in most climates at very irregular intervals and expend their fury on those rich alluvial plains, where herds of herbivorous quadrupeds congregate together. These animals are often surprised, and, being unable to stem the current, are hurried along until they are drowned, when they sink at first immediately to the bottom. Here their bodies are drifted along, together with sediment, into lakes or seas, and may then be covered by a mass of mud, sand and pebbles thrown down upon them.

"Where the body is so buried in drift sand, or mud accumulated upon it, as never to rise again, the skeleton may be preserved entire; but if it comes again to the surface while in the process of putrefaction, the bones commonly fall piecemeal from the floating carcass, and may in that case be scattered at random over the bottom of the lake, estuary, or sea, so that a jaw may afterwards be found in one place, a rib in another, a humerus in a third—all included, perhaps, in a matrix of fine materials where there may be evidence of very slight transporting power in the current, or even of none, but simply of some chemical precipitate."

Entire skeletons of animals or their bones scattered over declivities or plains are not so likely to be gathered together and deposited in some spot, because, as we have seen, they become subject to decay and dissipation., and because it would

appear that any wide-spread catastrophes killing large numbers of a herd are rare, and in the case of individual deaths, the remains, if carried by freshets to some lower level, would seldom undergo the same vicissitudes and be buried at the same point. Yet the wholesale destruction of mammals in a state of nature may be considered a possibility, though improbable. Sir Samuel H. Baker speaks[10] of cattle introduced at his camp at Fatiko, in Africa, who could not live there, " as the herbage was quite different to that to which they had been accustomed." They died so rapidly and in such numbers that in three months only three or four remained out of as many thousand. In the over stocked ranches of California, thousands of heads of sheep have been seen lying dead in vast heaps in ravines and valleys, as if nourishment had become exhausted by draught or by actual deplenishment of the available pasturage. Is not a similar mortality possible under natural conditions when, as in the case of the Fatiko cattle, animals have been driven by storms into localities incapable of their support, or when, as with the ranch sheep of California, an area previously put under severe strain for the support of its feral population, by an accident of weather or season fails entirely to furnish its occupants with food ?

Wallace in his Malay Archipelago speaks of the destructive effects of drought upon animal life in the Arne Islands, where from an excessive scarcity of water, "sometimes hundreds of birds and other animals die." The effects of sudden and violent falls of hail and snow are noticed by Stansbury, who found on the shores of the Great Salt Lake, a large number of young pelicans killed by the severity of a hail storm. The possibility of numbers of animals becoming buried at once, may be illustrated in the condition of the banks of the River Vaal in South Africa, of which Dr. Holub says that "its banks almost to the very middle of the channel are so soft and slippery, that draught animals going to drink are liable to sink so deep into the mud that it is impossible to extricate them." The internecine strife of wild animals may itself result in the accidental death of numbers, as when the hunters

[10] Ismailia, Sir S. H. Baker. p. 294.

—the carnivora—pursue their prey and drive them into lakes or rivers or, perhaps, force them over precipices. Dr. Hayden has observed similar occurrences, and in the same place where he records this observation corroborates the interesting suggestion of Lyell as to animals meeting their death by falling through thin ice. He says: "The wolves watch the deer, antelope and other feebler animals as they go down to the streams to drink, and all over the wide bottoms are the skeletons of these animals in a more or less perfect condition. It is not an uncommon occurrence for a band of wolves to attack an aged buffalo too old to offer a successful resistance. He must always betake himself to the river, where he is not unfrequently drowned, or is destroyed by the wolves on a sand bar or island. Annually thousands of buffaloes are drowned in attempting to cross the Missouri on the ice, as it is breaking up in the spring. Their bodies have been seen floating down the Missouri at Fort Union and Fort Clark by hundreds, and lodging on some of the islands or sand bars in the river. In the spring of 1858 several thousand bodies of buffaloes passed down the Kansas River below the mouth of Solomon's Fork and were carried into the Missouri."

Dr. Holub speaks of the devastation amongst oxen, elands, hartebeests, sheep, goats, wild pigs, etc., wrought by the attacks of hyenas in South Africa as "really frightful," and in pliocene times on our globe similar causes may have led to the collection of important groups of fossils. Even the instincts of animals may lead to their wholesale destruction. Mosely speaks of the migration of turtles at Ascension Islands saying, "the young turtles on leaving the egg go down to the sea and disappear, returning only when full grown to breed; this is the account given by the residents. If they do really leave the neighborhood of the island, there seems no possible means by which they can find their way back."

Although it is impossible that any of the fish beds, found as fossils, can, at least in paleozoic or mesozoic rocks, have been formed in the way instanced by Nordenskiold as a cause of death amongst arctic fish, yet the circumstance is intrinsically interesting, and the the reflections it suggests as to the likeli-

hood of general destruction from other causes of the fish in geological strata, wherein they abound, make it a useful point of reference in this matter. Nordenskiold says (Voyage of the Vega), " a large number of fish (*Gadus polaris*) were seen above the foot of a large block of ground ice, near which we lay to for some hours. Next day we saw near one of the islands, where the water was very clear, the sea-bottom bestrewed with innumerable fish of the same species. They had probably perished from the same cause, which often kills fish in the river Obi in so great numbers that the water is infected, namely, from a large shoal of fish having been inclosed by ice in a small hole, where the water, when its surface has frozen, could no longer by absorption from the air replace the oxygen consumed, and where the fish have thus been literally drowned."

However accumulated, whether by the sudden death of large numbers of animals by floods and storms along the banks of streams or the margins of lakes, or whether from other natural causes animals perish in numbers and upon restricted areas, their bones are carried by water action into the depressions, sinks, crevices and basins of a country, and being there sealed up from decomposition or dispersion by the silt and gathering accretions of various mineral deposits above them, they become fossils. The caves in limestone districts receive a contribution of animal remains partially brought into them by surface water partially by the the predatory instincts of carnivorous mammalia or birds. Prof. Hartt in his Geology of Brazil instances the interesting examples in the Sao Francisco basin wherein the numerous caverns, extending sometimes two thousand feet into the rock, furnish abundant remains both of long extinct mammalia as the Glyptodon, Mastodon, Mylodon, Megatherium, Chlamydotherium, Toxodon and Macrauchenia, and innumerable remnants of the smaller living animals brought there by owls, whose bones mingle with those of other occupants, as bats and felidæ. These variously distributed in the different caves were mingled in a red clay earth more or less cemented and encrusted by a stalagmitic crust. Similarly fossil vertebrates have been entombed in the caves of England, France, Belgium, Spain,

Sicily, Germany, Russia and Australia. Many of these caves open by vertical fissures to the surface, and down these irregular holes and chimneys the bones have been washed, while in some cases as at Wirksworth, in Derbyshire, England, or at the *cave* in the limestone at Port Kennedy, Pa., described by C. M. Wheatley, animals may have plunged into them and died in their imprisonment. Once gathered in their final resting place the process of burial goes on, in many cases rapidly, and in others slowly, and, according to the completeness of their sepulture, the condition of the bone is more or less perfectly preserved. In river floods the animals or osseous debris borne forward in their waters are soon enveloped in the midst of the accompanying clay, sand, gravel and calcareous mud torn from the channel and banks of the stream. They sink to the bottom and are rapidly covered in by a rising blanket of deposition. In caves and hollow receptacles the infiltrating streams bring constant additions of mud, and by their erosive action upon the surrounding limestone which they dissolve, they redeposit carbonate of lime through the interstices of the granular accumulation or form a hard layer above it, upon which again later ossuaries may be made, and the cave floor offer a study of separate and successive periods.

Amongst the multitudinous details connected with the exploration of caves for the traces and evidence of prehistoric man, the following facts have some reference to the fossilization of terrestrial vertebrates. A cave at Gailenreuth, Germany, contains an enormous quantity of bones and teeth of animals formerly living in its vicinity, and according to Dr. Buckland, introduced by a stream which passed through this chain of caverns in its subterranean course to lower levels. In the cave of Kühloch, Germany, a black animal dust covers the whole floor to the depth of six feet, derived says the same authority "from comminuted and pulverized bone." This accumulation is attributed to the use of the cave by bears through centuries.[11] In the caves of North Wales near St.

[11] The habits of wild animals in resorting to caves is fully established by observation. The custom of the panthers to make lairs of natural caves is instanced by Prof. Baird, and Major Pinto speaks of a circular chamber in a limestone mountain in Western Africa as a "regular haunt of wild beasts, as one might

Asaph, the bones are in a similarly pulverulent state and produce clouds as they are disturbed. In a cave at Banwell in the Mendip Hills, England, thousands of bones of bison, horse and reindeer were taken out of a red silt which filled the cave to its roof. The entire deposit has been introduced by water through a vertical fissure which opened on the surface. In the Hyena Den, at Wookey Hole, "the organic remains were in all stages of decay, some crumbling to dust at the touch, while others were perfectly preserved and had lost very little of their gelatine." In an arm or section of this same cavern according to Dawkins, "most of the bones were as soft as wet mortar," an interesting statement which throws light upon the probable state of maceration which bones attain before disappearance by trituration or solution. The mineralization of the bones in the various caves, so patiently explored, presents striking differences. In some the bone seems reduced to the last stages of cohesion, while in others it has become filled with carbonate of lime or partially silicified, and attains a considerable gravity.

(*To be continued.*)

THE GEOGRAPHICAL DISTRIBUTION OF BATRACHIA AND REPTILIA IN NORTH AMERICA.

By E. D. Cope.

(*Continued from page 902.*)

III. The Eastern Subregion.

The fauna of Batrachia and Reptilia of this subregion is characterized by what it lacks as much as by what it possesses. The number of species which occupy its entire extent exclu-

judge from the air which was perfectly saturated with the pungent smell of certain animals, as well as from the traces of a lion impressed on the impalpable powder which covered the ground, where we met with a few quills of the *Hystrix africana*."

sively of other subregions is small, while a larger number are restricted to parts of it. Verrill divided it into four districts, viz.: the Carolinian, the Alleghenian, the Canadian, and the Hudsonian. These are distinguished by the ranges of mammals and reptiles, and the breeding-places of birds. The Carolinian fauna extends in a belt north of the Austroriparian subregion, from Long Island, south of the hill region of New Jersey, to the southeastern corner of Pennsylvania, and thence inland. It embraces a wide belt in Maryland and Virginia, and all of central North Carolina, and then narrows very much in passing round south of the Alleghenies of Georgia. It extends north again, occupying East Tennessee, West Virginia, Kentucky, Indiana, the greater parts of Illinois and Ohio, and the southern border of Michigan. It includes southern Wisconsin and Minnesota, all of Iowa, and the greater part of Missouri. The Alleghenian embraces the States north of the line just described, excepting the regions pertaining to the Canadian fauna, which I now describe. This includes northern Maine, New Hampshire and Vermont, with the Green Mountains, the Adirondacks and summits of the Allegheny Montains as far as Georgia. It includes Canada east and north of the lakes. The Hudsonian fauna is entirely north of the isothermal of 50°. It has great extent west of Hudson's Bay, and is narrowed southeastward to Newfoundland.

The information as to the distribution of the Batrachia and Reptilia now at hand, points to the following conclusions. The Hudsonian fauna need not be further referred to here, as it is part of the Holarctic region. The Canadian is sustained, as defined by the range of certain Batrachia. The demarkation between the Alleghenian and Carolinian is determined by the northern limit of most of the species common to the Eastern and Austroriparian subregions. An important division is indicated by the boundaries set to the range of certain species by the Allegheny Mountains. This division affects chiefly the Carolinian district of Verrill, and I therefore propose to abolish that name, and replace it by the two terms Cisalleghenian for Eastern, and Transalleganian for the Western districts. They are separated from each other by the Alleghenian district of

the foot hills, and the Canadian of the summits of the Allegheny Mountains.

The species which are found over the entire eastern subregion, and not elsewhere, are the following:

Amblystoma jeffersonianum Green.
Plethodon cinereus Green.
Rana silvatica Lec.
Rana palustris Lec.
Osceola doliata triangula Boie.
Natrix fasciata sipedon Linn.
Eutænia sirtalis graminea Cope.

The Canadian district is characterized by the following species, which are restricted to it:

Amblystoma jeffersonianum laterale Hallow.
Gyrinophilus porphyriticus Green.
Desmognathus ochrophæa Cope.
Desmognathus nigra Green.
Bufo lentiginosus fowlerii Putn.
Rana cantabrigensis Baird.
Rana septentrionalis Baird.

The list above given as universally distributed in the Eastern subregion characterizes *the Alleghenian district.* I know of no species that is restricted to it. The genera which do not extend north of it are the following:

BATRACHIA:

Chorophilus,
Hyla,
Hemidactylium,
Cryptobranchus.
Necturus.

SAURIA:

Sceloporus,
Eumeces.

SERPENTES:

Carphophiops,
Coluber,
Cyclophis,
Natrix,
Ophibolus,
Heterodon,
Ancistrodon.
Systrurus,
Crotalus,

The two remaining districts include the large number of species which are common to the Eastern and Austroriparian subregions enumerated under the latter head. The Cisalleghenian is further characterized by the following:

Hyla andersonii Bd.	*Ophibolus rhombomaculatus* Holbr.
Rana virgatipes Cope.	

To these must be added from the Austroriparian list: *Abastor erythogrammus* Daud.

The following species are peculiar to the *Transalleghenian district:*

Chondrotus microstomus Cope.	*Eutænia radix* B. & G.
Spelerpes maculicaudus Cope.	*Eutænia butlerii* Cope.
Rana areolata circulosa R. & D.	*Tropidoclonium lineatum* Hallow.
Carphophiops vermis Kenn.	*Natrix kirtlandii* Kenn.
Coluber vulpinus B. & G.	*Systrurus catenatus* Raf.
Ophibolus calligaster Say.	

Probably *Eutaenia brachystoma* Cope belongs to this district but only one specimen has been found.

The following species enter this district only from the Austroriparian:

Natrix grahamii B. & G.	*Eutænia proxima* Say.

Of the species peculiar to the Transalleghenian district, *Ophibolus calligaster* and *Tropidoclonium lineatum* extend into the northern limits of the Texan district.

The genera which do not range northward of the Cisalleghenian district are Cnemidophorus, Liolepisma and Abastor.

The total number of species of the Eastern subregion is thus:

Generally distributed,	7
Peculiar to Cisalleghenian,	3
Peculiar to Transalleghenian,	9
Peculiar to Canadian,	7
Common to Austroriparian,	34
	60

IV. The Austroriparian Subregion.

This subregion is the range of a large number of species of Batrachia and Reptilia, only a part of which occupy it to the exclusion of all other subregions, and another series of which occupy parts only of its area. Three centers of distribution

within its borders may be discerned—the Ocmulgian, the Louisianian and the Texan. The Texan is especially characterized by the combination of the Austroriparian fauna with a considerable number of the species of the Sonoran subregion. The characteristic Austroriparian species are the following:

TRACHYSTOMATA:

Siren lacertina L.

URODELA:

Amphiuma means Gard.
Amblystoma talpoïdeum Holbr.
Manculus quadridigitatus Holbr.

SALIENTIA:

Bufo lentiginosus lentiginosus Shaw.
Chorophilus occidentalis B. & G.
Hyla carolinensis Penn.
Engystoma carolinense.

LORICATA:

Alligator mississippiensis Daud.

SAURIA:

Ophisaurus ventralis Daud.
Anolis carolinensis.

SERPENTES:

Heterodon simus Linn.
Cyclophis æstivus Linn.
Zamenis flagelliformis Catesb.
Coluber spiloides D. & B.
Compsosoma corais couperii Holbr.
Osceola doliata syspila Cope.
Osceola doliata coccinea Schl.
Ophibolus getulus sayi Hobr.
Cemophora coccinea Blum.
Natrix clarkii B. & G.
Natrix fasciata fasciata L.
Natrix fasciata erythrogaster Shaw.
Natrix cyclopium D. & B.
Virginia valeriæ B. & G.
Haldea striatula L.
Tantilla coronata B. & G.
Elaps fulvius L.
Ancistrodon piscivorus Lacep.
Systrurus miliarius L.
Crotalus adamanteus adamanteus Beauv.

Thirty-one species and subspecies.

The Austroriparian shares with the Floridan subregion all of the above species except *Coluber spiloides, Natrix clarkii, Virginia valeriæ* and *Haldea striatula,* so far as yet known. It shares with the Eastern subregion the following thirty-four species.

PROTEIDA:

Necturus maculatus Raf.

URODELA:

Cryptobranchus alleghaniensis Daud.
Amblystoma opacum Grav.
Amblystoma punctatum L.
Amblystoma tigrinum Green.
Plethodon glutinosus Green.
Spelerpes guttolineatus Holbr.
Spelerpes ruber Daud.
Desmognathus fusca Raf.
Diemyctylus viridescens Raf.
Bufo americanus americanus Lec.
Scaphiopus holbrookii Harl.
Acris gryllus Lec.
Hyla versicolor Lec.
Rana pipiens pipiens Kalm.
Rana areolata B. & G.
Rana clamata Daud.
Rana catesbiana Shaw.

SAURIA:

Sceloporus undulatus Latr.
Cnemidophorus sexlineatus L.
Eumeces quinquelineatus L.
Liolepisma laterale Say.

SERPENTES:

Abastor erythrogrammus Daud.
Carphophiops amœnus Say.
Heterodon platyrhinus Latr.
Diadophis punctatus L.
Liopeltis vernalis L.
Zamenis constrictor L.
Coluber obsoletus Say.
Pityophis melanoleucus Daud.
Ophibolus getulus getulus L.
Eutænia sirtalis sirtalis L.
Ancistrodon contortrix L.
Crotalus horridus L.

The following species are restricted to the eastern part of the Austroriparian subregion, not extending west of the Atlantic drainage. To this district I have the name of *the Ocmulgian.*

PROTEIDA:

Necturus punctatus Gibbs.

URODELA:

Stereochilus marginatum Hallow.
Chondrotus cingulatus Cope.

SALIENTIA:

Bufo quercicus Holbr.
Chorophilus ornatus Holbr.
Chorophilus oculatus Holbr.

SERPENTES:

Abastor erythrogrammus Daud.
Rhadinæa flavilatus Cope.
Coluber quadrivittatus Holbr.
Natrix rigida Say.

The following species are restricted to the Ocmulgian and Louisianian districts with present information. First, all the Batrachia which the Austroriparian subregion shares with the Eastern, excepting *Amblystoma tigrinum*, *Diemyctylus viridescens*, *Acris gryllus*, *Rana areolata*. Second, *Farancia abacura* Holbr., *Coluber guttatus* L.

The following species are to be added to the general Austroriparian (p. 1007) to form the list of the Texan district:

PROTEIDA:

Typhlomolge rathbunii Stejn.

URODELA:

Diemyctylus meridionalis Cope.
Chondrotus texanus Matth.

SALIENTIA:

Bufo debilis B. & G.
Bufo punctatus B. & G.
Bufo valliceps Wiegm.
Bufo compactilis Wiegm.
Lithodytes latrans Cope.
Chorophilus triseriatus clarkii B. & G.

SAURIA:

Holbrookia texana Trosch.
Holbrookia maculata B. & G.
Crotaphytus collaris Say.
Sceloporus spinosus Wiegm.
Sceloporus consobrinus B. & G.
Phrynosoma cornutum Harl.
Eublepharis variegatus Bd.
Gerrhonotus liocephalus Wiegm.
Eumeces epipleurotus Cope.
Eumeces pachyurus Cope.
Eumeces brevilineatus Cope.
Eumeces tetragrammus Bd.
Eumeces obsoletus B. & G.

SERPENTES:

Diadophis amabilis docilis B. & G.
Diadophis amabilis stictogenys Cope.
Hypsiglena ochrorhynchus Cope.
Rhinochilus lecontei B. & G.
Coluber emoryi B. & G.
Osceola doliata annulata Kenn.
Ogmius episcopus episcopus Kenn.
Natrix rhombifera Hallow.
Natrix fasciata transversa Hallow.
Virginia elegans Kenn.
Eutænia proxima Say.
Eutænia elegans marciana B. & G.
Eutænia eques ocellata Cope.
Tantilla gracilis B. & G.
Tantilla nigriceps Kenn.
Systrurus catenatus edwardsii B. & G.
Crotalus adamanteus atrox B. & G.

Sixty-one species and subspecies, making a total for the Austroriparian as follows:

Generally distributed, ...	31
Shared with the Eastern subregion, ...	34
Ocmulgian only, ...	10
Louisianian and Ocmulgian only, ...	2
Texan exclusively (in the subregion), ...	38
	115

The species which enter the Texan territory from the Sonoran extend to various distances to the north and east. Thus, *Crotaphytus collaris* ranges to southern Missouri, and *Holbrookia maculata* to Arkansas. *Sceloporus spinosus* extends along the Gulf States to western Florida. *Phrynosoma cornutum* extends eastward to Dallas, Texas. *Rhinochilus lecontei* on the other hand has not been found east of Austin. Several species from the extreme southwest of Texas have not been included in the above lists, since some of them are well-known to belong to the Central American fauna, while the range of others is probably similar, but is not sufficiently known. Of the former kind are *Drymobius margaritiferus* Schl., *Sibon albofuscum* Lac., and *Coniophanes imperialis* B. & G.; of the latter are *Lystoptychus lateralis* Cope, *Holbrookia propinqua* B. & G. and *Hypopachus cuneus* Cope.

V. The Floridan Subregion.

The species and subspecies peculiar to this subregion are the following:

BATRACHIA:

Pseudobranchus striatus Lec.
Hyla gratiosa Lec.
Rana areolata æsopus Cope.

SAURIA:

Eumeces egregius Bd.
Rhineura floridana Bd.

SERPENTES:

Coluber rosaceus Cope.
Coluber guttatus sellatus Cope.
Osceola doliata parallela Cope.
Stylosoma extenuatum Brown.
Eutænia sackenii Kenn.
Seminatrix pygæa Cope.
Natrix usta Cope.
Natrix compressicauda Kenn.
Natrix fasciata pictiventer Cope.
Liodytes allenii Garm.

Species which are wanderers from the West Indian region are:

Lithodytes ricordii D. & B.
Sphærodactylus notatus Bd.
Crocodilus americanus Seba.

The *Rhadinæa flavilatus* Cope ranges throughout both the Floridan subregion and the Ocmulgian district. Two other species may be characteristic of the Floridan subregion, but only one specimen of each has been obtained. These are *Manculus remifer* Cope, and *Elaps distans* Kenn.

Species which the Floridan subregion shares with the Austroriparian are the following:

TRACHYSTOMATA:

Siren lacertina L.

AMPHIUMOIDEA:

Amphiuma means Gard.

PSEUDOSAURIA:

?*Plethodon glutinosus* Green.

SALIENTIA:

Bufo lentiginosus lentiginosus Shaw.
Bufo quercicus Holbr.
Hyla squirella Bosc.
Hyla femoralis Latr.
Hyla carolinensis Penn.
Acris gryllus Lec.
Chorophilus nigritus Lec.
Scaphiopus holbrookii Harl.
Rana pipiens sphenocephala Cope.
Rana castesbiana Shaw.

LORICATA:

Alligator mississipiensis Daud.

SAURIA:

Sceloporus undulatus Latr.
Cnemidophorus sexlineatus L.
Liolepisma laterale Say.
Eumeces quinquelineatus L.

SERPENTES:

Heterodon simus L.
Diadophis punctatus L.
Abastor erythrogrammus Daud.
Farancia abacura Holbr.
Coluber guttatus L.
Coluber quadrivittatus Holbr.
Zamenis constrictor L.
Zamenis flagelliformis Shaw.
Compsosoma corais couperii Holbr.
Pityophis melanoleucus Daud.
Ophibolus getulus getulus L.
Osceola doliata coccinea Schl.
Osceola elapsoidea Holbr.
Storeria dekayi Stor.
Natrix fasciata erythrogaster Shaw.
Natrix cyclopium D. & B.
Natrix taxispilotus Holbr.
Eutænia sirtalis sirtalis L.
Tantilla coronata B. & G.
Elaps fulvius L.
Systrurus miliarius L.
Crotalus adamanteus adamanteus L.

The total number of species of the Floridan subregion is as follows:

Peculiar species,	15
Species common to the Ocmulgian district,	1
Species common to the Louisianian district,	40
Species common to the West Indian region,	3
Little known species,	2
	61

VI. The Sonoran Subregion.

This subregion presents several natural divisions, as follows: I. The Lower Californian district, including only the region at the extremity of the peninsula of Lower California; II. The Chihuahuan district, embracing the State of Sonora, Mexico, the northern part of the Mexican Plateau, Arizona south of the San Francisco Mountains, most of the peninsula of Lower California, and most of New Mexico; III. The Basin district, embracing the Great Basin of Utah and Oregon, to Vernon, British Columbia; and IV. The Central district, which includes the high plains east of the Rocky Mountains, from Texas northward, excepting the river bottoms which cross it from west to east. This great subregion is bound together by the general distribution of numerous genera; but I do not know a single species which covers its entire area which is not found elsewhere. These define the districts.

The Lower Californian district is defined by the following fourteen species, which are restricted to it:

Hyla curta Cope.
Ctenosaura hemilopha Cope.
Uta thalassina Cope.
Uta nigricauda Cope.
Phyllodactylus unctus Cope.
Cnemidophorus maximus Cope.
Euchirotes diporus Cope.
Lichanura trivirgata Cope.
Zamenis aurigulus Cope.
Phyllorhynchus decurtatus Cope.
Pityophis vertebralis Blv.
Chilomeniscus stramineus Cope.
Tantilla planiceps Blv.
Crotalus enyo Cope.

The district shares with the Chihuahuan the following species:

Bufo punctatus B. & G.
Dipsosaurus dorsalis Hallow.
Crotaphytus wislizenii B. & G.
Callisaurus draconoides Blv.
Sauromalus ater Dum.
Uta stansburiana B. & G.
Uta ornata B. & G.
Sceloporus zosteromus Cope.
Phrynosoma coronatum Blv.
Phyllodactylus tuberculosus Wiegm.
Salvadora grahamiæ B. & G.
Ophilobolus getulus boylii B. & G.
Chilomeniscus fasciatus Cope.
Hypsiglena ochrorhynchus Cope.
Natrix valida Kenn.
Eutænia eques Reuss.
Trimorphodon lyrophanes Cope.
Crotalus adamanteus atrox B. & G.
Crotalus mitchellii Cope.

Species common to the Lower Californian district and the Western subregion (mostly to the Diegan district) are the following:

Hyla regilla B. & G.
Phrynosoma coronatum Blv.
Verticaria hyperythra Cope.
Gerrhonotus multicarinatus Blv.
Opibolus getulus boylii B. & G.
Opibolus getulus californiæ Blv.
Plethodon croceater Cope.

Total species of the Lower Californian district:

Peculiar to it, ...	14
Common to the Chihuahuan district, ...	18
Common to the Western subregion, ...	7
	39

Thirty-eight species, one being twice enumerated as common to the Chihuahuan district and Western region.

The Chihuahuan district possesses the following peculiar species:

BATRACHIA SALIENTIA:

Bufo alvarius Grd.
Hyla arenicolor Cope.

SAURIA:

Ctenosaura multispinis Cope.
Crotaphytus reticulatus Bd.
Callisaurus notatus Bd.
Callisaurus rufopunctatus Cope.
Callisaurus inornatus Cope.
Callisaurus scoparius Cope.
Uta symmetrica Bd.
Uta bicarinata Dum.
Uta graciosa Hallow.
Sceloporus clarkii B. & G.
Sceloporus couchii B. & G.
Sceloporus jarrovii Cope.
Sceloporus ornatus B. & G.
Phrynosoma solare Gray.
Anota modesta Gir.
Anota maccallii Hallow.
Heloderma suspectum Cope.
Gerrhonotus multifasciatus D. & B.
Cnemidophorus tessellatus Say.
Cnemidophorus inornatus B. & T.
Cnemidophorus octolineatus B. & S.
Cnemidophorus guttatus B. & G.
Eumeces guttulatus Hallow.

OPHIDIA:

Glauconia dissecta Cope.
Glauconia dulcis B. & G.
Glauconia humilis B. & G.
Lichanura roseofusca Cope.
Diadophis regalis regalis B. & G.
Heterodon nasicus kennerlyi Kenn.
Zamenis semilineatus Cope.
Coluber emoryi B. & G.
Rhinechis elegans Kenn.
Pityophis sayi sayi Schl.
Epiglottophis pleurostictus D. & B.
Ophibolus getulus splendidus B. & G.
Chionactis occipitalis Hallow.
Chilomeniscus ephippicus Cope.
Gyalopium canum Cope.
Eutænia megalops Kenn.
Eutænia elegans marciana B. & G.
Eutænia elegans dorsalis B. & G.
Eutænia augustirostris Kenn.
Eutænia nigrilatus Brown.
Eutænia rufopunctata Cope.
Eutænia multimaculata Cope.
Trimorphodon upsilon Cope.
Trimorphodon lambda Cope.
Trimorphodon wilkinsonii Cope.
Scolecophis æmulus Cope.
Elaps euryxanthus Kenn.
Crotalus molossus B. & G.
Crotalus scutulatus Kenn.
Crotalus lepidus Kenn.
Crotalus cerastes Hallow.

Fifty-eight species, disposed of as follows: Batrachia salientia, 2; Sauria, 25; Serpentes, 31. Three species of Testudnata are peculiar to this district, viz.: *Kinosternum henrici* Lec., *K. flavescens* Agass., *Xerobates agasizii* Cooper. This district possesses a larger number of peculiar species than any other in the Medicolumbian Region.

The Basin district has but few peculiar species. Its southern boundary may be regarded as the San Francisco Mountains in northern Arizona. The *Crotalus tigris* which is restricted to it has been shown by Merriam to inhabit only the mountains, and its northern limit is as yet unknown. The following are the species of the Great Basin:

BATRACHIA:

Amblystoma tigrinum Green.
Spea intermontana Cope.*
Rana draytonii onca Cope.*
Rana pipiens brachycephala Cope.*

SAURIA:

Crotaphytus collaris Say.†
Crotaphytus wislzenii B. & G.†
Uta stansburiana B. & G.†
Sceloporus biseriatus Hallow.†
Sceloporus graciosus B. & G.†
Sceloporus consobrinus B. & G.†
Phrynosoma douglassii ornatissimum Gird.†
Anota platyrhina Gird.†
Zamenis tæniatus Hallow.†
Pityophis sayi bellona B. & G.†
Chionactis episcopus isozonus Cope.*
Eutænia elegans vagrans B. & G.
Crotalus tigris B. & G.†
Crotalus confluentus lecontei Hallow.

The species and subspecies peculiar to the Basin district are marked with a star, and those found also in the Chihuahuan with a dagger.

The Central district possesses but few peculiar species. These with certain Chihuahuan species give it a distinctive character. There are also a few species which enter it from the Eastern subregion. These are marked with a dagger, while the peculiar forms are marked with a star.

URODELA:

Amblystoma tigrinum Green.

SALIENTIA:

Bufo cognatus Say.*

Spea hammondii bombifrons Cope.*

SERPENTES:

Heterodon nasicus nasicus B. & G.*

Ophibolus multistratus Kenn.*

Zamenis constrictor L.†

Eutænia radix B. & G.†

Eutænia sirtalis parietalis Say.

Eutænia elegans vagrans B. & G.

Crotalus confluentus confluentus Say.

SAURIA:

Crotaphytus collaris Say.

Holbrookia maculata B. & G.

Phrynosoma douglassii hernandesii Gir.*

Eumeces septentrionalis Bd.*

Eumeces multivirgatus Hallow.†

Eumeces obsoletus B. & G.

The species not marked with dagger or star are Chihuahuan, except *Eutænia elegans vagrans*, which is also found in the Basin district, *E. sirtalis parietalis*, which extends to the Pacific district, and the *Amblystoma tigrinum*, which is Medicolumbian throughout.

The total number of species of the Sonoran subregion is as follows:

Peculiar to the Chihuahuan district, ...	58
Common to Lower Californian and Chihuahuan districts,	19
Peculiar to the Lower Californian district, ...	14
Peculiar to the Basin district, ...	6
Common to the Basin and Chihuahuan, ...	8
Peculiar to the Central district, ...	8
Common to the Central and Chihuahuan, ...	3
Common to the Chihuahuan and Texan, ...	14
	126
Doubles emplois, ...	4
	122

VII. The Western Subregion.

This subregion presents two distinct modifications, a northern and a southern. The boundary between the two has not yet been defined; it represents the demarkation between the greater humidity of the north and the arid conditions of the south. The name of Diegan has been given by Mr. Van Denberg to the southern region; to the northern I propose to restrict the name Pacific, which I formerly used for the entire subregion, which had been previously named the Western by Baird. The Pacific district extends further south along the Sierra Nevada than in the San Joaquin Valley. Some of the forms of the Diegan district extend north to the latitude of San Francisco, but the majority of the species are restricted to more southern latitudes. How far the Diegan district extends on the Lower Californian Peninsula is uncertain. The separation from the Chihuahuan district is also undertermined, and the species of both districts mingle in some degree on their borders.

Species peculiar to the Diegan district are the following:

Batrachia:

Bufo columbiensis halophila B. & G.

Sauria:

Uta repens Van Denberg.
Uta mearnsii Stejneger.
Sceloporus orcuttii Stejneger.
Sceloporus vandenbergianus Cope.
Phrynosoma cerroënse Stejneger.
Anota goodei Stejneger.
Xantusia vigilis Bd.
Xantusia riversiana Cope.
Xantusia picta Cope.
Zablepsis henshavii Stejneger.
Amæbopsis gilbertii Van Denburg.
Verticaria sericea Van Denberg.
Cnemidophorus tessellatus multiscutatus Cope.
Cnemidophorus tessellatus rubidus Cope.
Anniella pulchra Gray.

Serpentes:

Lichanura orcuttii Stejn.
Diadophis amabilis amabilis B. & G.
Crotalus ruber Cope.

To these must be added the species already enumerated as common to the Diegan and Lower Californian districts, and the following list of species which occur also in the Chihuahuan district:

Crotaphytus wislizenii B. & G.
Callisaurus draconoides Blv.
Uta stansburiana B. & G.
Sceloporus biseriatus Hallow.
Lichanura roseofusca Cope.
Crotalus adamanteus atrox B. & G.

The following species are common to the Diegan and Pacific districts:

BATRACHIA:

Diemyctylus torosus Esch.
Hyla regilla B. & G.*

SAURIA:

Phrynosoma blainvillii Gray.
Gerrhonotus multicarinatus Blv.*
Gerrhonotus burnettii Gray.
Eumeces skiltonianus B. & G.

SERPENTES:

Charina bottæ Blv.
Zamenis lateralis Hallow.
Zamenis tæniatus Hallow.*
Pityophis catenifer Blv.
Ophibolus getulus boylii B. & G.*
Eutænia elegans couchii Kenn.*
Eutænia infernalis infernalis Blv.
Crotalus confluentus lucifer B. & G.

These species are then characteristic of the Western subregion as a whole, except those marked with a star, which occur elsewhere.

The Pacific district is especially characterized by certain genera and species of Batrachia. No certainly known genus of scaled reptiles, and a limited number of species and subspecies are peculiar to it. Conspicuous among these are the species of Eutænia, which display great variety, while they are but sparsely represented in the Diegan district. The peculiar species are as follows:

URODELA:

Amblystoma macrodactylum Baird.
Amblystoma epixanthum Cope.
Chondrotus paroticus Baird.
Chondrotus decorticatus Cope.
Chondrotus aterrimus Cope.
Chondrotus tenebrosus B. & G.
Batrachoseps caudatus Cope.
Batrachoseps attenuatus Esch.
Plethodon intermedius Bd.
Plethodon oregonensis Gird.
Autodax lugubris Hallow.
Autodax iëcanus Cope.
Autodax ferreus Cope.
Diemyctylus torosus Esch.
Bufo columbiensis columbiensis B. & G.
Spea hammondii hammondii Bd.
Rana temporaria pretiosa Bd.
Rana cantabridgensis latiremis Cope.
Rana agilis aurora B. & G.
Rana draytonii Baird.
Rana boylii Baird.

SAURIA:

Sceloporus undulatus occidentalis Bd.
Phrynosoma douglassii douglassii Bell.
Gerrhonotus principis B. & G.
Cnemidophorus septemvittatus Cope.

SERPENTES:

Diadophis amabilis pulchellus B. & G.
Zamenis constrictor vetustus B. & G.
Contia mitis B. & G.
Eutænia elegans elegans B. & G.
Eutænia elegans lineolata Cope.
Eutænia elegans ordinoides B. & G.
Eutænia infernalis vidua Cope.
Eutænia sirtalis parietalis Say.
Eutænia sirtalis trilineata Cope.
Eutænia sirtalis pickeringii B. & G.
Eutænia sirtalis tetratænia Cope.
Eutænia sirtalis concinna Hallow.
Eutænia biscutata Cope.
Eutænia leptocephala B. & G.

There are therefore peculiar to the Pacific district eighteen species and three subspecies of Batrachia (two species found in the Holarctic region represented by subspecies, and one species

from the Canadian); two species and two subspecies of lizards; and three species and eleven subspecies of snakes.

We have of species and subspecies of the Western subregion the following synopsis:

Peculiar to the Diegan district, ...	19
Common to the Diegan and Chihuahuan, . .	6
Common to the Diegan and Pacific, ...	11
Peculiar to the Pacific, ...	39
	75

VIII. The Toltecan Subregion.

This subregion includes three districts which possess characteristic species, and which differ in climate. The Austroriental is a humid region with abundant rains and fogs, and includes the eastern face and slope of the central plateau, with the mountain elevations, including parts of the States of Puebla, Vera Cruz, Hidalgo and San Louis Potosi. It is cut off to the north from the Austroriparian subregion by an interval in the States of Nuevo Leon and Tamaulipas. The middle or Austrocentral district includes the valleys of Mexico and Toluca, and the region northward to the edge of the Sonoran subregion, including the State of Guanajuato, and perhaps further north. The climate of this district is much less humid than that of the Austroriental district. The Austroccidental district includes the high lands of Oaxaca, Guerrero, Michoacan and Jalisco. It is the most arid of the three divisions, and extends furthest to the south and west.

The northern boundary of the Toltecan district is not yet determinable; hence it is not possible to state whether species from the States of Durango and Zacatecas, such as *Eutænia angustirostris*, should be referred to it or not. A small collection made by Wilkinson in southern Chihauhua at Batopilas[1] has the character of the Chihuahuan fauna, with the following species not otherwise found in it:

Anolis nebulosus Wiegm.
Uta bicarinata Dum.
Scolecophis æmulus Cope.

[1] Cope, Proceeds. Amer. Philosoph. Soc., 1879, p. 261.

The humid and dry districts of the Toltecan subregion repeat *in petto* the differences between the Austroriparian and Sonoran subregions. The Austroriental district is distinguished by the larger number of batrachian genera and species, and of certain genera of Crotalidæ. It also includes some genera which may be regarded as immigrants from the Central American region of the Neotropical Realm.

The characteristic species of the *Austrocentral district* are[2]:

BATRACHIA URODELA:

Siredon mexicanum Shaw.
Amblystoma tigrinum Green.

BATRACHIA SALIENTIA:

Bufo compactilis Wiegm.
Bufo intermedius Gthr.
Spea multiplicata Cope.
Spea hammondii Bd.
Hyla eximia Bd.
Hyla arenicolor Cope.
Rana montezumae Bd.

TESTUDINATA:

Kinosternum pennsilvanicum.
Onychotria mexicana Gray.

SAURIA:

Phrynosoma orbiculare Wiegm.
Sceloporus scalaris Wiegm.
Sceloporus microlepidotus Wiegm.
Sceloporus torquatus Green.
Sceloporus minor Cope.
Sceloporus melanogaster Cope.
Barissia imbricata Wiegm.
Cnemidophorus guttatus B. & G.
Eumeces brevirostris Gthr.

SERPENTES:

Conopsis nasus Gthr.
Toluca lineata Kenn.
Chionactis varians Jan.
Salvadora bairdii Jan.
Epiglottophis pleurostictus D. & B.
Hemigenius variabilis Dugés.
Natrix storerioides Cope.
Eutænia macrostemma Kenn.
Eutænia eques Reuss.
Eutænia pulchrilatus Cope.
Eutænia scaliger Jan.
Eutænia melanogaster Wiegm.
Tantilla bocourtii Gthr.
Tantilla calamarina Cope.
Crotalus basiliscus Cope.
Crotalus polystictus Cope.

[2] For the exact habitat of several of these I am indebted to the important papers of Dr. A. Dugés, in La Naturaleza, 1888, p. 97, and 1896 p. 3.

Of these species the following occur in the Chihuahuan district:

Amblystoma tigrinum Green.
Spea hammondii Bd.
Hyla arenicolor Cope.
Sceloporus scalaris Wiegm.
Sceloporus microlepidotus Wiegm.
Cnemidophorus guttatus B. & G.
Epiglottophis pleurostictus D. & B.
Eutænia macrostemma Kenn.
Eutænia eques Reuss.

The Austroriental district includes the mountainous region which bounds the Mexican Plateau on the east, from some part of the State of Puebla to a point to the north not yet ascertained. It is probably separated by a considerable interval from the Austroriparian in the States of Tamaulipas and Nuevo Leon. Its climate is moist, and vegetation is abundant, and of principally Medicolumbian type. Various peculiar species of Acer, Platanus, Quercus, Andromeda and other forms are abundant. The Batrachian and Reptilian species are the following:[3]

BATRACHIA URODELA:

Spelerpes chiropterus Cope.
Spelerpes leprosus Cope.
Spelerpes cephalicus Cope.
Spelerpes orizabensis Blatchley.
Spelerpes gibbicaudus Blatchley.
Oedipina lineola Cope.
Thorius penuatulus Cope.

BATRACHIA SALIENTIA:

Hyla gracilipes Cope.
Hyla miotympanum Cope.
Hyla bistincta Cope.
Smilisca baudinii D. &. B.

SAURIA:

Sceloporus variabilis Wiegm.
Sceloporus æneus Wiegm.
Sceloporus microlepidotus Wiegm.
Phrynosoma orbiculare Wiegm.
Phrynosoma taurus Dugés.
Barissia imbricata Wiegm.
Barissia antauges Cope.
Gerrhonotus gramineus Cope.
Gerrhonotus tæniatus Wiegm.
Gerrhonotus liocephalus Wiegm.

[3] For a knowledge of the distribution of many of these species I am indebted to Francois Sumichrast, in Archives des Sciences, in Bibliotheque Universelle, 1873, p. 233, and *in litteris*.

Celestus enneagrammus Cope.
Liolepisma laterale Say.
Anelytropsis papillosus Cope.

SERPENTES:

Atractus latifrontalis Garm.
Ficimia olivacea Gray.
Epiglottophis lineaticollis Cope.
Osceola doliata polyzona Cope.
Ninia diademata B. & G.
Storeria dekayi Stor.
Storeria occipitomaculata Holbr.
Rhadinæa vittata Jan.
Rhadinæa decorata Gthr.
Eutænia sumichrastii Cope.
Eutænia chrysocephala Cope.
Eutænia pulchrilatus Cope.
Eutænia scalaris Cope.
Eutænia phenax Cope.
Sibon frenatum Cope.
Sibon personatum Cope.
Sibon albofuscum Lac.
Bothriechis mexicanus D. & B.
Ophryacus undulatus Jan.
Systrurus ravus Cope.
Crotalus triseriatus Wagl.

Of all the above species the following are found also in the Austrocentral district:

Barissia imbricata Wiegm.
Sceloporus variabilis Wiegm.
Sceloporus microlepidotus Wiegm.
Phrynosoma orbiculare Wiegm.
Eutænia pulchrilatus Cope.

Species found in the Austroriparian subregion:

Liolepisma laterale Say.
Storeria dekayi Stor.
Storeria occiptomaculata Holbr.

To the Austroriental list might be added *Spelerpes bellii* Gray, which is stated by Sumichrast to inhabit also the Tierra Caliente; and *Anolis nannodes* Cope, which the same authority says ranges from the Tierra Caliente into the Alpine district. The water-snake *Natrix rhombifera* Hallow. may occur in the Austroriental district, but this needs confirmation.

The *Austroccidental district* is inhabited by a number of peculiar species, together with some which occur in the other two districts of the Toltecan subregion. One peculiarity of this district is the poverty in Batrachia and the absence of Urodela. The peculiar species are the following:

BATRCHIA ANURA:

Leptodactylus melanonotus Hallow.
Hypopachus variolosus Cope.

SAURIA:

Sceloporus siniferus Cope.
Sceloporus horridus Wiegm.
Sceloporus rubriventris Gthr.
Sceloporus pyrrhocephalus Cope.
Sceloporus omiltemanus Gthr.
Sceloporus dugesii Boc.
Sceloporus bullerii Boul.
Sceloporus heterolepis Boul.
Cnemidophorus deppei lineatissimus Cope.
Eumeces callicephalus Boc.

SERPENTES:

Pseudoficimia frontalis Cope.
Sympholis lippiens Cope.
Atractus omiltemanus Gthr.
Adelophis copei Dugés.
Rhadinæa laureata Gthr.
Eutænia godmanii Gthr.
Chionactis michoacanensis Dugés.
Coniophanes lateritius Cope.
Conophis vittatus Pet.
Himantodes gemmistratus latistratus Cope.
Sibon personatum Cope.
Manolepis nasutus Cope.

Of the above species there are found in the Tierra Caliente:

Sceloporus siniferus Cope.
Sceloporus horridus Wiegm.
Sceloporus pyrrhocephalus Cope.
Conophis vittatus Pet.
Sibon personatum Cope.
Manolepis nasutus Cope.

And in the region south to Costa Rica:

Hypopachus variolosus Cope.
Himantodes gemmistratus Cope.

The Austroccidental district shares with the Austrocentral the following:

BATRACHIA ANURA:

Bufo compactilis Wiegm.
Hyla eximia Bd.
Rana pipiens austricola Cope.

SAURIA:

Phyllodactylus tuberculosus Wiegm.
Uta bicarinata Dum.
Barissia imbricata Wiegm.

Cnemidophorus guttatus B. & G.
Sceloporus scalaris Wiegm.
Phrynosoma orbiculare Wiegm.
Anolis nebulosus Wiegm.

SERPENTES:

Drymobius margaritiferus Schl.
Diadophis lætus Cope.
Osceola doliata polyzona Cope.
Hemigenius variabilis Dugés.
Natrix storerioides Cope.
Eutænia eques Reuss.
Eutænia melanogaster Wiegm.
Epiglottophis pleurostictus D. & B.
Tantilla calamarina Cope.
Trimorphodon biscutatus D. & B.
Trimorphodon upsilon Cope.
Crotalus triseriatus Wagl.
Crotalus polystictus Cope.
Crotalus basiliscus Cope.

A number of species inhabit the Austroccidental and Austroriental districts, passing to the southward of the Austrocentral, at least so far as present information extends. These are the following:

BATRACHIA ANURA:

Smilisca baudinii D. & B.

SAURIA:

Sceloporus torquatus Green.
Phrynosoma taurus Dugés.
Gerrhonotus oaxacæ Gthr.

SERPENTES:

Rhadinæa vittata Jan.
Eutænia chrysocephala Cope.
Coniophanes proterops Cope.
Ophryacus undulatus Jan.
Crotalus triseriatus Wagl.

The species of the Toltecan subregion are as follows:

Austroriental district,	44
Austrocentral district,	36
Austroccidental district,	24
	73
Doubles emplois,	2
	71

VIII. Recapitulation.

The number of species of Reptilia Squamata of the Medicolumbian region is as follows. The species of Batrachia have been already enumerated in my book on that class.[4]

Superfamilies.	Families.	Genera.	Species.
	SAURIA.		
Pachyglossa	Iguanidæ	12	79
Nyctisaura	Gecconidæ	2	2
	Eublepharidæ	1	1
Helodermatoidea	Helodermidæ	1	1
Diploglossa	Anguidæ	4	17
Leptoglossa	Tiidæ	2	11
	Xantusiidæ	3	5
	Scincidæ	2	20
	Anelytropsidæ	1	1
Annielloidea	Anniellidæ	1	2
Annulati	Euchirotidæ	1	1
	Amphisbænidæ	1	1
	Total Sauria	31	141
	SERPENTES.		
Catodonta	Glauconiidæ	1	3
Colubroidea	Boidæ	1	3
	Charinidæ	1	2
	Colubridæ	26	133
	Dipsadidæ	10	19
	Elapidæ	1	3
Solenoglypha	Crotalidæ	5	25
	Total Serpentes	45	188
	Sauria	31	141
Total Squamata		76	329

[4] The Batrachia of North America, Bulletin of the U. S. Natl. Museum, No. 34, 1889, p. 451. The species of the Toltecan subregion are mostly omitted from this book.

EDITOR'S TABLE.

It is difficult to eradicate from scientific literature a name or word which has become current, even after it has been found to be an expression of ignorance or error. Thus some names introduced into Zoology die hard. It is perfectly well-known that the grouping of forms named by Cuvier Pachydermata, is entirely unnatural, and the appropriate positon of all of its contents has been exactly determined; yet the word occasionally crops up still in the literature. The supposed primary divisions of fishes Ganoidei and Teleostei, have a still more vigorous vitality, although it is perfectly clear that there is no use for either term. The supposed Ganoid division is thoroughly heterogeneous, its contents forming with the Teleostei a more comprehensive division, the Teleostomi of Owen, which naturally falls into several primary divisions three of which were included in the Ganoidei by Agassiz and Müller. Perhaps the most pestilent pretender of the list, is the word Amphibia, which is so frequently used instead of the proper name of the class Batrachia. The name Amphibia was originally applied to a combination of the Reptilia and Batrachia, before the fundamental differences between the two were known. When the Batrachia were first separated from the Reptilia, the new name was naturally applied to the new division, and the name Amphibia would have been more applicable to the larger division of its former self i. e. the Reptilia. As, however, its definition accorded with neither the Reptilia nor Batrachia, it was not used for either, nor was it introduced to take the place of Batrachia with a definition, until a few years ago by Huxley. This was done in defiance of the universal usage of naturalists at the time, and probably in ignorance of the real state of the case, since it frequently happens that men engaged in the real work of biological science, find questions of names irksome and stupid. Nevertheless it is a distinct advantage always to have but one name for one thing; and that name should be the oldest which was applied to the thing in question as determined by the definition given. Applying this principle, the name Batrachia has a quarter century priority over Amphibia.

In the April, 1896 number of this journal (p. 292) we published what purported to be a review of a work by Wachsmuth and Springer, which was signed by one of our frequent contributors. In a foot note the work is stated to have been published in 1895. We have learned

from leading authorities on the subject of the work, (the Crinoidea), that it was not published at the time the review was issued, nor it is yet published. We make this statement, since it is important that the date of publication of all books, especially scientific books, should be correctly ascertained and reported, and because we desire to prevent any confusion as to the date of this particular publication which might arise from our having published the review in question. As is usual with periodicals, we assume no responsibility for articles published in the NATURALIST unless they are anonymous.

The dates of publication of the numbers of the AMERICAN NATURALIST during the years 1895, and 1896 are as follows: for 1895; Jan., Jan. 15th; Feb., Feb. 14th; March, Mch. 6th; April, Apl. 9th; May, May, 13th; June, June 3d; July, July 9th; August, July 31st; Sept., Aug. 28th; Oct., Sept. 26th; Nov., Oct. 29th; Dec., Dec. 6th.

For 1896; Jan., Dec. 31st, 1895; Feb., Jan. 30th; March, Mch. 9th; April, Apl. 2d; May, May 2d; June, June 3d; July, July 2d; August, Aug. 6th; Sept., Sept. 9th; October, Oct. 3d; Nov., Nov. 2d; Dec., Dec. 5.

RECENT LITERATURE.

Gregory's Plant Anatomy.[1]—Among the host of botanical textbooks that are constantly appearing, it is a pleasure to welcome one that is a contribution to certain departments of botanical literature, rather than a mere exposition of the laboratory and lecture methods, good, bad, and chiefly indifferent, of the author. While it is to be assumed that American investigations in histology and in cytology have not been lacking during these past few years, the fact remains that they have not as yet resulted in an increase of literature upon these subjects.

While there can be no doubt that the tide is setting steadily and strongly in the direction of higher things in cisatlantic botany, this is as yet a premonition rather than a fact, and the few texts leading toward this are to be regarded as pioneers and valued as such. These books are divisible into two classes, and in evaluating them, it is necessary to measure them by a proper standard. Thus, a book which purports to be a textbook should not be criticized because it does not manifest

[1] Elements of Plant Anatomy, by Emily L. Gregory, Ph. D. Professor of Botany in Barnard College. Ginn & Co., Boston, 1895, pp. VIII, 148. 8vo.

the depth and comprehensiveness of an exhaustive treatise, nor should an elaborate work on original investigation be supposed to cover the details of elementary science.

The present book is intended to serve as an introduction to the elements of phytotomy. This purpose is effected more than ordinarily well. It is no mean task to distinguish between the relevant and the irrelevant, between the essential and the non-essential in the construction of an elementary text. In these very points, the author has been particularly happy, and deserves congratulation upon the coherency and the coordination manifested in the text.

A striking feature of the book is its prevailing clearness. Many otherwise well written and helpful text-books are marred by the fact that too much is written between the lines, a thing deplorable in any scientific writing, but especially so in an elementary one. The author has succeeded, however, not only in establishing delightful perspicacity of style, but also in maintaining it throughout the work. In consequence, the beginner may find here a text which presents in a remarkably easily assimilated condition those rudiments of plant anatomy which should serve as a foundation for advanced botanical study in all lines.

The merits of the book are many and obvious, and warrant passing its few defects in silence. Its inspiration is readily recognizable as of the German school, an additional point in its favor were it not for a prefatory remark to which the reviewer must enter serious objection. The author states that "it is quite certain that the measure of our progress in any science may be found in our ability to adapt the thought and experience of other nations to our special needs and resources," a statement of such a very peculiar nature that comment is superfluous.

The book is divided into two parts, the first of which treats of cytology, or, as the author terms it, the anatomy of the cell. Under this, the first chapter treats of the cell as a unit, the second and third present the subjects of cell-wall and cell-contents in their modern aspects. The second part discusses the anatomy of tissues, first generally, and then more specially, with reference to the thoroughly antiquated divisions, Thallophytes and Cormophytes. The last chapter, the irrelevancy of which is excused by its importance, is devoted to an exposition of the secondary growth of stems and roots.—FREDERIC E. CLEMENTS.

Boulenger's Catalogue of Snakes in the British Museum.[1] —In this work we have a manual of Ophiology in which the subject is

[1] Catalogue of the Snakes in the British Museum. Vol. I, 1893; vol. II, 1894; vol. III, 1896. By G. A. Boulenger, F. R. S.

as nearly as possible brought up to date. The especial advantage of being the work of the Keeper of the largest collection of Ophidians in the world, makes this catalogue of especial value to all students. The author informs us that there are known 1639 species of snakes, of which 1327 are represented in the collection of the British Museum by 11092 specimens.

A good deal of valuable new osteological work enters into the systematic, which will be at once recognized by specialists. Thus the determination of the forms which have elongate hypapophyses throughout the vertebral column is here made for the first time, and the discovery that all the Colubridæ of Madagascar have the prolonged series of hypapophyses, is one of the notable announcements of the work. The peculiar pterygoids of the Amblycephalidæ are the author's discovery, as are also the split ectopterygoids of Dispholidus, etc., and the confluent optic foramina of the Psammophiinæ[2] The labor of specific determination of over 11000 specimens, in an order where variation is often conspicuous, is, however, the great feature of such a work as this, and even the approximately complete form in which it is now presented, is a monument to the industry and acumen of its author, and a service rendered to science by the British Museum which will always remain.

There are, however, some spots on the face of this illuminating ing production. The labor of determining the true limits of variable species has in a good many instances, it seems to us, proven too much for the patience of the author, and he has resorted to the convenient method of "lumping" too often. He has given up a valuable feature of the older catalogues, the list of doubtful species. In the present work all published species are either good or bad, whether the author has had the requisite opportunity of determining their true status or not. Thus it has happened in not a few instances that names relegated to the synonymy in the body of the work are reintroduced in the Addenda as belonging to good species. Had the author the material it is probable that a good many others would have been recognized before the final issue of the Catalogue. The author has been especially unfortunate in his treatment of North American species, and the student of North American Ophiology will not find his knowledge of this subject increased by this publication. Some of the species studies are on the other hand very thorough, as for instance the genera Vipera and Naja. The revision of the synonymy of both the older and later European authors is a service for which all herpetologists will be grateful.

[2] I mention here that the genera Malpolum, Psammophis, Mimophis and Rhamphiophis have no protrusible male intromittent organ. For this reason I propose to arrange them as a special subfamily, the Psammophiinæ.

The primary divisions of the Ophidia (or Serpentes as they should be called) adopted, are nine families, which have very different values. These can be associated in superfamilies of approximately equal value, but this Dr. Boulenger has not done, but has contented himself with giving an analytical table (pp. 1–2), where some of the characters of these superfamilies are pointed out, in the dichotomous order, which does not express relative value. Many groups usually regarded as families are not recognized, as for instance the Najidæ and Dipsadidæ, which are included in the Colubridæ. In a phylogenetic table the interesting suggestion is made that the Solenoglyphous snakes are derived from the Opisthoglyphous, and not from the Proteroglyphous.

In seeking for generic characters the dentition has been closely examined. The value of dental characters has been thoroughly tested, and the result is valuable to the student, although we do not always agree with the use made of the information in the Catalogue. The author does not adopt the characters used by Duméril and Bibron in many instances, for good reasons, but he introduces others of his own which are no better, as the numbers and in some cases the relative lengths of the teeth. In practice it is often impossible to determine whether teeth are of equal length or a little longer at one or the other end of the jaw; nor is the number of the teeth in the jaws precisely definitive of anything but species, as can be readily seen from the results recorded in the present work. The division or union of the anal plate and urosteges, is generally rejected as a character, although its value is testified to by the uniform use made of it by ophiologists. In fact the generic definitions are based on no uniform principle, and the author seems to have been possessed at times with the idea that it were an especial merit to differ as much as possible from his predecessors.

One result of the study of this work will be to prove to ophiologists that it is desirable to become acquainted with new characters of definitive value before we can have the true system of the snakes. An important addition to our knowledge in this direction, i. e. of the characters of the hemipenis and of the lungs, came too late to be incorporated in the present work.—E. D. Cope.

Nuttall's Handbook of Birds.[1]—A new edition, with important additions, and a series of more than one hundred colored illustrations.

[1] *A Popular Handbook of the Ornithology of Eastern North America.*—By Thomas Nuttall. Revised and annotated by Montague Chamberlain. Vol. I, *Land Birds.* Vol. II *Game and Water Birds* Second edition, with corrections and additions Illustrated with one hundred and seventy-two figures, two colored

This favorite work, easily understood, handy, and popular, including all of Nuttall's delightful descriptions of bird-life, which was some time since fully annotated by Montague Chamberlain, who added the birds not known in Nuttall's time, will be found more useful and valuable than ever before, Mr. Chamberlain having again gone over the work with the greatest care, bringing the information down to date.

Colored representations of the birds being desirable for amateurs and students, a series of twenty plates, containing one hundred and ten figures of birds, has been added to the present edition. The drawings have been mostly copied from those of Wilson, and may be relied on for accuracy, although in some instances the tints do not come up to the brilliancy of Nature. We recommend the book as the one for the family, where the strictly scientific side of ornithology is not the chief desideratum. We mean by this that the work is not devoted to the anatomy and physiology of birds, but is one by which the species may be identified, and where descriptions of their habits and geographical range may be found; all set forth in admirable style.

Education of the Central Nervous System.[2]—This book is an endeavor to apply the most recent results of psychology and brain physiology to the theory of education. The author quotes from Donaldson and other well-known writers on the topography of the brain and localization of functions. In view of the close connection between cerebral development and mental capacity, he advocates an education which shall develop all parts of the brain to the greatest possible extent. He recommends especially that children be trained to distinguish every shade of sensation-difference, and to recall in vivid images the objects of every kind which they have experienced; if such training be begun early in life, the brain cells are better developed, and in after life our mental images are more numerous and more definite.

Unfortunately the book is limited almost exclusively to a discussion of sensation and memory, leaving out of account entirely the higher rational processes. It becomes an appeal for an education which is fundamentally æsthetic and literary, as distinguished from scientific. Book-learning for children is decried, and teachers are urged to take their pupils out into the woods and fields, and have them learn from

frontispieces, and twenty colored plates, containing one hundred and ten figures of the most important land and water birds. 2 vols. Crown 8vo. Cloth, extra, gilt top, $7.50 *net;* half crushed Levant morrocco, extra, gilt top, $13.50 *net.*—Little, Brown & Co., Publishers, 254 Washington Sreet, Boston.

[2] The Education of the Central Nervous System, by R. P. Halleck. New York, The Macmillan Co., 66 Fifth Ave. 1896. Pp. xii, 258; price $1.

nature herself. This was the education, the author thinks, which made Shakespere really great. The study of nature is certainly of value, and the author's recommendations, together with the practical exercises in sense-training which he gives, will doubtless be an aid to this culture. But in these days of the supremacy of science, it is far more important to begin early to lay the foundations of habits of correct scientific thinking. The possession of clear and vivid mental imagery is a factor in correct thinking, of course; but unless accompanied by the logical treatment of ideas it is quite as likely to lead us in the wrong as in the right direction.

As a manual on the education of the central nervous system Mr. Halleck's work is very incomplete; it must be supplemented in several directions, and notably by a considerable amount of that very "book-learning" which the author treats so lightly. The treatment of motor education is inadequate, being confined to a single short chapter at the end of the book. By way of minor criticism, we may notice the author's fondness for repeating the same illustrations (e. g., pp. 82, 248). Some of his deductions are based on very inadequate data (e. g., p. 64); but this is rather the fault of his authorities. His list of great men who began to show talent at an early age, though large, calls to mind so many exceptions as to throw considerable doubt on the position which it seeks to establish.

The chapter entitled: "How Shakspere's Senses were Trained," is interesting to the student of literature, though somewhat too detailed. Throughout the book there is a wealth of quotations from Shakespere, Milton, and other writers, which add to its literary finish, if they do not improve its scientific quality.—H. C. W.

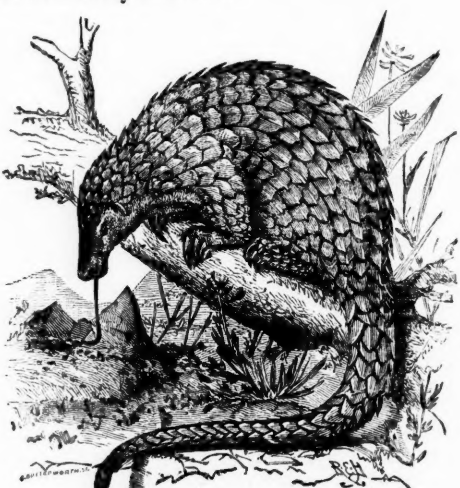
Lydekker on the Geographical History of Mammalia.[1]—I have already referred to this work in the last number of the NATURALIST in a paper on the Geographical Distribution of Batrachia and Reptilia of North America. I then pointed out that the author adopts the three Geographical realms of Huxley with the reasons why in my opinion the Ethiopian should constitute a fourth Realm. The divisions of the Notogæic Realm of Lydekker's system, are the Australian, Polynesian, Hawaiian and Austromalayan. The Neogæic realm has a sole region, the Neotropical. The Arctogæic is divided into the Malagasy, the Ethiopian, the Oriental, the Holarctic, and the Sonoran. Having otherwise disposed of the Ethiopian and its subdivision the Malagasy,

[1] The Geographical History of Mammals; by R. Lydekker A. B., F. R. S., V. P. G. S., etc. Cambridge University Press, 1896. 8vo. pp. 400.

I adopted the three remaining regions, the Oriental, the Holarctic, and the Medicolumbian; the last name being derived from Blanford, and used as a substitute for Sonoran, which have been previously used for a subdivision.

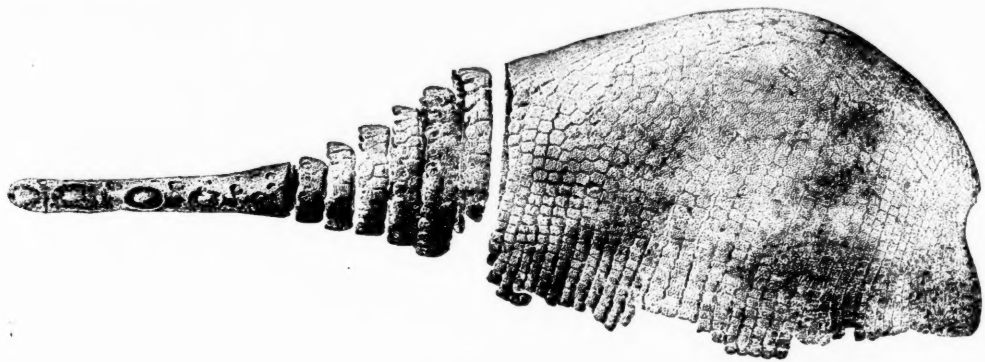
This work is a magazine of information on the subject of which it treats, and a unique feature is the large amount of reference to the facts of paleontology. This increases the value of the book to the general reader, but cannot be said to be germane to its main object. The introduction of the extinct forms of life necessarily changes the aspect of the faunal lists of a country to a marked degree, nowhere more so than in the Arctogæan Realm. Each geological period had in fact its own geographical distribution of forms, and when all are discovered a series of books on geographical distribution in each period might be written, each different from every other one.


Plagiaulax minor from the English Wealden; much enlarged.


Manis tricuspis West Africa.

The well-known familiarity of the author of this book with both Mammalian zoölogy and paleontology, gives it a value which no similar book possesses; and its compact form and fulness of illustration

PLATE XXVIII.



External skeleton of *Panochthus tuberculatus* from Argentina; much reduced.

make it especially convenient for the traveller who reads as he goes. The author writes clear and direct English, and correct classical orthography. His systematic of the Mammalia given on p. 11 is uncritical, though it includes most of the groups brought to light by paleontology. More detailed classification in later chapters elucidates the subject further.

The accompanying three illustrations give a good idea of their their general character.—E. D. COPE.

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General Notes.

PETROGRAPHY.[1]

The Sioux Quartzite of Iowa.—The Sioux quartzite has long been known as the oldest sedimentary rock in Iowa. It has recently been studied by Beyer.[2] It is a white or red vitreous rock with which is associated as its upper extension a series of mottled reddish or purplish-black slates. The quartzites present the usual aspects of indurated sandstones. The constituent quartz grains are rich in 'quartz-needles' which can be traced directly into rutile spicules. The slates are arenaceous. They exhibit no traces of slaty cleavage, though in some cases their quartz grains and micaceous constituents are distorted in such a way as to testify to a horizontal movement in the rock mass containing them. All the slates are mottled by spheroidal masses of a lighter color than the body of the rock. These masses are spheroidal with the longer dimensions of the spheroids in the bedding planes of the shale. Their lighter color is supposed to be due to the removal of iron from those portions of the rock they occupy. Associated with the quartzites is a great mass of olivine diabase consisting of a coarse grained aggregate of labradorite and oligoclase zonally intergrown, olivine, augite, biotite, hornblende, apatite and magnetite. Most specimens are much altered, the components having been changed into the usual secondary substances common to diabase. In structure the rock varies from the ophitic, in which the plagioclase is older than the augite, to the gabbroitic, in which the augite is the older mineral. An analysis gave:

SiO_2	TiO_2	Fe_2O_3	FeO	Al_2O_3	CaO	MgO	K_2O	Na_2O	H_2O	P_2O_5	Total
42·85	tr	13.66		20.23	6.85	3.42	1.90	5.78	.88	tr	= 100.57

The Peridotites of North Carolina.—In connection with a discussion of the occurrence and origin of corundum in North Carolina, Lewis[3] gives us an interesting account of the basic rocks associated with the gneisses in that portion of the Appalachian belt included within the limits of the State. These basic rocks, consisting mainly of

[1] Edited by Dr. W. S. Bayley, Colby University, Waterville, Me.
[2] Iowa Geol. Survey, Vol. VI, p. 69.
[3] Bull. No. 11, North Carolina Geol. Survey, 1896.

peridotites, occur in small lenticular masses or in narrow strips, which are always enveloped in a sheet of schistose talc or chlorite, and thus are never in direct contact with the gneisses through which they are believed to cut. They are classed as peridotites, pyroxenites and amphibolites, the former being the most common. The peridotites present several types in each occurrence, all merging into one another and forming a single geological unit. The principal types of the peridotites are dunite, harzburgite, amphibole-picrite and forellenstein. All are massive, as a rule, though exceptions are noted. The dunite is composed of olivine grains, octahedrons and rounded grains of picotite and chromite, plates of enstatite, prisms of light green hornblende and various alteration products of these, the most common being serpentine tremolite and chlorite. The Harzburgite and the other peridotites present no unusual features. They appear to be transition phases between the dunite and the various pyroxenites among which are recognized two types, an enstatite rock and websterite. The enstatite rock is made up almost exclusively of enstatite or bronzite and its alteration product talc. An analysis of the enstatite gave:

SiO_2	Al_2O_3	FeO	CaO	MgO	MnO	H_2O	Total
51.64	.12	9.28	.45	31.93	.56	5.45	99.43

The amphibolites are composed chiefly of amphibole. The most important type is composed of grass-green hornblende, anorthite and more or less corundum. The rock is fine grained and it is usually gneissic, although occasionally massive. Transitions through forellenstein into dunite were observed, although the distribution of the rock suggests its occurrence in a system of dykes cutting the latter rock. The hornblende has the following composition:

SiO_2	Al_2O_3	Cr_2O_3	FeO	NiO	MgO	CaO	NaO	K_2O	H_2O	Total
45.14	17.59	.79	3.45	.21	16.69	12.51	2.25	.36	1.34	= 100.33

Genth called the mineral smaragdite. Dana regards it as edenite. In addition to the rocks mentioned above, there are also present in the region massive serpenite, which was unquestionably derived from dunite, talc-schists, and soapstones derived from enstatite rocks and chlorite schists.

In a second paper[4] the same author gives his reasons for considering these rocks as eruptive in origin.

Shales and Slates from Wales.—Hutchins[5] continues his studies of clays, shales and slates by an investigation of the nature of

[4] Elisha Mitchell Sci. Soc. Jour., Pt. II, 1895, p. 24.

[5] Geol. Mag., Vol. III, 1896, p.

shales taken from some of the deepest coal mines in Wales. The chemical composition of the particular shale analyzed does not differ materially from that of some of the carboniferous shales from other coal fields. Physically the deeper shales are not much more compact than hard clays. The author reviews the results of his observations on shales and slates. He states that what takes place in a rock during its progress from clay to shale, is the development and crystallization of muscovitic mica and the production of chlorite. He also calls attention to the fact that dynamic metamorphism is made to explain many phenomena connected with the crystallization of slates, that are capable of being explained better by static metamorphism. The spots of many contact rocks are now thought to be secretions from a mineralizing solution, depositing in these spherical forms material collected from the rock body. By crystallization the spots pass over into cordierite, biotite or staurolite crystals.

Notes.—Cushing[6] declares that in addition to the rocks described by Kemp from the eastern Adirondacks there is a system of diabase dykes, which are older than the monchiquites and camptonites of the district.

By melting certain rock powders in the presence of reagents Schmutz[7] has obtained aggregates of minerals which in most cases are very different from those composing the original rocks. Eklogite fused in the presence of calcium and sodium fluride yielded a mass of meionite, plagioclase and glass; leucitite with calcium chloride gave a mass composed of a glassy groundmass and plagioclase; with the addition of sodium fluride and potassium silico-fluride it yielded scapolite, mica, magnetite; with sodium chloride it produced augite, scapolite and magnetite and a glass matrix. Granite fused with magnesium and calcium chlorides and sodium fluoride gave andesine and olivine in a groundmass containing augite. Other rocks treated with other reagents gave analagous results.

As the result of a series of experiments made with the view of discovering a medium with a very high specific gravity that will not attack sulphides, Retgers[8] finds that the acetate and the mixed nitrate and acetate of thallium are both neutral toward sulphides. The former is available for separating minerals with a density below 3.9, and the latter those with a density below 4.5.

[6] Trans. N. Y. Acad. Sci., XV, 1896, p. 249.
[7] Neues Jahrb. f. Min., etc., 1896, I, p. 211.
[8] Neues Jahrb. f. Min., etc., 1896, I, p. 213.

In an article in the *Neues Jahrbuch* Bauer[9] gives a German transcription of his article[10] on the rocks associated with the jadeite of Turmaw, Burmah.

Schroeder vander Kolk[11] describes briefly a series of rocks collected by Martin in the Moluccas. In the southern part of Amboina the rocks are mainly granite and peridotite, while in the larger northern part they consist of modern volcanics, as they do also on the other islands studied. These rocks are principally dacites and liparites, but on one island andesites occur. Both the dacites and the granite contain cordierite. The dacites are pyroxene and biotite varieties. The andesites are pyroxenic; mica schists, breccias and limestones occur also on the islands. The residue left after treatment of the limestone with acid contains quartz, sanidine, plagioclase, biotite, amphibole, orthorhombic pyroxene, hematite, garnet, cordierite, sillimanite and pleonost.

BOTANY.[1]

The Evolution of a Botanical Journal.[2]—In November of the present year the *Botanical Gazette* reaches its majority, by attaining the age of twenty-one years. It first appeared in November, 1875 under the name of the *Botanical Bulletin*, and consisted of four pages of short notes. It was edited by John M. Coulter, then professor of Natural Sciences in Hanover College (Hanover, Indiana). In his introductory note the editor stated that the object of the new journal was "to afford a convenient and rapid means of communication among botanists. The context shows that it was started as a distinctly western journal, intended to supplement the work of eastern botanical publications.

The first volume included notes by the editor, and Thomas C. Porter, Samuel Lockwood, G. C. Broadhead, M. S. Coulter, Mary E. Pulsifer Ames, J. T. Rothrock, H. C. Beardslee, Coe F. Austin, George Vasey, Alphonso Wood, Isaac Martindale, Elihu Hall, E. A. Rau, and others who have long since diappeared from the botanical field. With the

[9] Neues Jahrb. f. Min., etc., 1866, I, p. 19.

[10] Cf. AMERICAN NATURALIST, June, 1896, p. 478.

[11] Ib., 1896, I, p. 152.

[1] Edited by Prof. C. E. Bessey, University of Nebraska, Lincoln, Nebraska.

[2] Read before the Botanical Seminar of the University of Nebraska. October 10, 1896.

opening of the second volume its name was changed to the *Botanical Gazette*, and the name of M. S. Coulter was added as joint editor. In 1883 by a reorganization of the management, John M. Coulter, Charles R. Barnes and J. C. Arthur became editors, an arrangement which proved to be so satisfactory to the botanists of the country as to become permanent.

The next few years were trying ones for the ambitious editors, but the impetus given to botanical thought by the incoming of modern methods in teaching and study, and perhaps, also, by the organization of the Botanical Club of the American Association for the Advancement of Science, proved helpful in many ways. The Philadelphia (1884) and Ann Arbor (1885) meetings of the Botanical Club created much botanical enthusiasm, the results of which accrued to the benefit of the *Gazette*.

The beginning of its second decade saw it much enlarged, improved in typography and apparently well established in the confidence of American botanists. Year by year it was still further increased in size, better paper was used, and the quality of the matter steadily improved. From the fifty-two pages of short, and mostly local, notes of volume I, we turn to the five hundred and sixty-eight pages of structural, physiological, ecological, systematic and palæontological matter in volume XX. With the opening of the twenty-first volume an additional enlargement was found to be necessary, the numbers averaging sixty-five pages each.

In the earlier volumes there were no plates, the first one occurring in volume VI, illustrating an article by J. C. Arthur on the trichomes of *Echinocystis lobata*. In the twentieth volume there were thirty-seven plates, while for the first half of 1896 the number was twenty-nine.

The last stage in the evolution of this important factor in American botany was reached a few months ago when its financial management was transferred to the University of Chicago. It thus happily becomes an endowed institution, and the editors, relieved from all anxiety as to its business management, are free to develop it along strictly scientific lines. To the three editors whose efforts have given it the foremost place place among botanical journals are hereafter to be added several "associate editors"; at present these are G. F. Atkinson, V. M. Spalding, Roland Thaxter and William Trelease. Under the new regime it promises to be more cosmopolitan than before, and accordingly we are assured that the names of one or more European botanists will soon be added to the corps of editors.

This factor in botanical science has thus been a growth, and it represents to-day much more than so many pages of printed matter. It has grown and developed as the science of botany has grown and developed in this country. When we look over the earlier volumes with surprise at the little notes which fill the pages, we must not forget that American botany had not then generally risen above such contributions. It is true that we had a few masters in the science, with Dr. Gray still in his prime, but these masters wrote little for general reading, and their technically systematic contributions were mostly published in the proceedings of learned societies. The one thing which stands out to-day in sharp contrast with the botany of two decades ago is the very great increase in the number of masters in the science who are making liberal contributions from many different departments. The many-paged *Gazette* of to-day, with its rich variety of matter, differs no more from the four-page *Bulletin* of 1876 than does the botany of the two periods.—CHARLES E. BESSEY.

The North American Species of Physalis and Related Genera.—In a recent number of the Memoirs of the Torrey Botanical Club (Vol. IV, No. 5) Mr. P. A. Rydberg publishes an important contribution to our knowledge of our species of Physalis and related genera. Every one who has attempted to accurately identify any of the native species of Physalis knows well how difficult and discouraging the task has been. Commenting on this Mr. Rydberg says: " The reason is not that the descriptions are so badly drawn, but that only about one half of the actual number of species have, as a rule, been recognized."

After a critical discussion covering fifteen pages the author characterizes the six genera which he includes in his monograph. These are *Margaranthus*, with four southwestern species; *Physalis*, with thirty-nine species; *Quincula*, with one Rocky Mountain species; *Leucophysalis*, with one species of the northern United States and Canada; *Chamæsaracha*, with four species of the southwestern United States; *Oryctes*, with one species from Nevada.

Throughout the paper the nomenclature and synonymy receive full attention, the citations being unusually complete. The descriptions are concise, and apparently drawn with great care. And last, but by no means least, there is a full index of species and synonyms given at the end of the monograph. Altogether it is an unusually good piece of work.—CHARLES E. BESSEY.

Professor Prentiss.—The recent death (August 14th) of Professor Albert Nelson Prentiss of Cornell University calls for more than a mere

brief mention. Born in Cazenovia, N. Y.; May 22, 1836; educated in the Oneida County Seminary, and the Michigan Agricultural College (B. Sc., 1861 and M. Sc., 1864). After short periods of service in the engineering corps of the United States Army, and the public schools of Michigan he became professor of botany in the Michigan Agricultural College (1863 to 1868). After six years of service he was called to the chair of botany in Cornell University (1868), where he remained for twenty-eight years when on account of failing health he was made professor *emeritus* (1896). In these years of work Professor Prentiss was emphatically a *teacher*. The building and equipment of his department, and the training of men who went out to be professors in many colleges, left little time for investigations and the preparation of papers. He chose to impress his thoughts upon men rather than upon paper, and he will be remembered not as a writer, but as a teacher. His life shows how much more effective our work is when we teach men directly by our spoken words rather than through our printed papers.—C. E. B.

The Nomenclature of Mycetozoa.—Professor Mac Bride has been studying the question of nomenclature among these organisms (plants he calls them, and, therefore his results are noticed here) and finds great difficulty in applying the "priority rule" to the solution of the problem. He calls attention to the well-known fact that the earlier botanists did not understand the nature of Mycetozoa and that their descriptions and even their figures in many cases are unintelligible. Rostafinski a little more than twenty years ago gave us the first rational account of the group, and for the first time gave us descriptions by means of which we may know certainly what he had in hand when he applied a particular name. His nomenclature is, therefore, to a large extent the earliest which is authentic. Practically all earlier descriptions are unrecognizable, and therefore, Rostafinski had to take up the work *de novo*. Professor Mac Bride says: "The fact is that when Rostafinski gives credit to his predecessors it is for the most part purely a work of courtesy and grace; there is nothing in the work itself to command such consideration." He therefore concludes that "the man who in his search for priority ascends beyond Rostafinski, does it at the risk of endless confusion and uncertainty in the great majority of cases" and that for these the initial date must be that of his great work, "Sluzowce Monografia" in 1875.—Charles E. Bessey.

The Flora of Wyoming.—Professor Aven Nelson of the University of Wyoming recently issued a valuable "First Report on the Flora of Wyoming," based upon field work in 1892 (by Professor Buf-

fum), 1894 and 1895 by Professor Nelson. The catalogue of plants includes 1118 species of Spermatophytes, 14 Pteriodophytes, 26 Bryophytes, 3 Algæ, 8 Fungi and 7 Lichens, making a total of 1176. The trees of Wyoming are listed as follows: Rocky Mountain Yellow Pine (*Pinus ponderosa scopulorum*), Rocky Mountain White Pine (*P. flexilis*), Lodge-pole Pine (*P. murrayana*), Engelmann's Spruce (*Picea engelmanni*), Blue Spruce (*P. pungens*), Douglas Spruce (*Pseudotsuga douglasii*), Red Cedar (*Juniperus virginiana*), Black Cottonwood (*Populus angustifolia*), Rydberg's Cottonwood (*P. acuminata*), Quaking Aspen (*P. tremuloides*), Sand-bar Willow (*Salix longifolia*), Almond Willow (*S. amygdaloides*), two other species (*S. flavescens, S. lasiandra*), Green Ash (*Fraxinus viridis*), Box Elder (*Negundo aceroides*), Scrub Oak (*Quercus undulata*), Wild Plum (*Prunus americana*), Wild Cherry (*P. demissa*), Choke Cherry (*P. virginiana*), Hawthorn, two species (*Crataegus rivularis* and *C. douglasii*), Service Berry (*Amelanchier alnifalia*), Silver Berry (*Elæagnus argentea*), Buffalo Berry (*Shepherdia argentea*), Black Birch (*Betula occidentalis*), Black Alder (*Alnus incana vireseeus*), Sage Brush (*Artemisia tridentata*).

The last species is sometimes so large that "a man on horseback may ride erect underneath the branches."

We notice a curious slip by which *Actinella glabra* Nutt. is listed among the new species, although it was published as a new species fifty-five years ago in the Transactions of the American Philosophical Society, and a year or so later appeared under Nuttall's name in Torrey and Gray s Flora of North America, II, p. 382.—Charles E. Bessey.

The Lichens of Chicago.—Bulletin No. 1, of the Geological and Natural History Survey of the Chicago Academy of Sciences is devoted to an enumeration of the lichens of Chicago and vicinity, by Mr. W. W. Catkins. One hundred and twenty-five species are enumerated and very briefly characterized. The paper is supplemented by a useful but incomplete Bibliography of North American Lichenology.—Charles E. Bessey.

Eastwood's Plants of Southeastern Utah.—In the Proceedings of the California Academy of Sciences (2d series, vol. VI) Miss Alice Eastwood enumerates 162 species collected in 1895 in the valley and on the plateaus of the San Juan River in southeastern Utah, a desert region with curious oases about springs and along cañons. Several new species are enumerated, three of which are figured in the plates which accompany the report.—Charles E. Bessey.

Correction.—On page 748, by a slip of the pen the "popple" of the Colorado Mountains is given as *Populus balsamifera candicans;* it should be *P. tremuloides.*—CHARLES E. BESSEY.

Botanical News.—A suggestive pamphlet on "The Pathology of Plants" by B. T. Galloway comes from the Office of Experiment Stations of the United States Department of Agriculture. Its object is to point out certain lines of work in plant pathology that might be undertaken by botanists in the state experiment stations.—From the Division of Agrostology, (U. S. Dept. Agriculture) we have "Fodder and Forage Plants, exclusive of the Grasses" a pamphlet of fifty-eight pages, by Jared G. Smith. It is a descriptive, illustrated list of these plants, written in semi-popular language. It will be of value not only to stock growers, but to scientific botanists as well—Professor W. J. Beal has recently published a Report of the Botanical Department of the Michigan Agricultural College from which we learn that there are in the herbarium 54,243 specimens, and that the botanic garden, begun in 1877 now contains 1335 species.—The Contributions from the U. S. National Herbarium (Vol. III, No. 9) issued August 5, 1896 contains the following papers: The Flora of Southwestern Kansas, a report on a collection of plants made by C. H. Thompson in 1893, by A. S. Hitchcock; *Crepis accidentalis* and its allies, by F. V. Coville; Plants from the Big-Horn Mountains of Wyoming, by J. N. Rose; Leibergia, a new genus of Umbelliferæ from the Columbia River Region, by J. M. Coulter and J. N. Rose; Roseanthus, a new genus of *Cucurbitaceæ* from Acapulco, Mexico, by Alfred Cogniaux.

ZOOLOGY.

Notes on Turbellaria.—1. ON THE OCCURENCE OF BIPALIUM KEWENSE (MOSELEY) IN THE UNITED STATES.

Since the appearance of Moseley's[1] paper in 1878 the species has been recorded from other parts of Great Britain and Ireland, and from Berlin and Frankfurt, A. M. on the continent. It has also been found at the Cape of Good Hope in Africa, in the colonies of Queensland, New South Wales and Victoria in Australia, at Auckland in New Zea-

[1] Moseley, H. N. Description of a New Species of Land-Planarian from the Hothouses at Kew Garden. Ann. Mag. Nat. Hist., Ser. 5. Vol. I, pp. 237–239 1878.

land, Upolu in Samoa and Joinville in Brazil. The wide distribution of this, the largest of land planarians, has doubtless been brought about through the agency of man, the well-marked genus being indigenous only in Japan, China, India, Ceylon, the Malay Archipelago and the East Indies, but this species, *Bipalium kewense,* has never been found in these countries; its home is unknown.

The purpose of this communication is to record the existence of the species in the United States. It is quite abundant in Cambridge, Mass., and has been found there in two different greenhouses. A methodical search would no doubt reveal it in others of the many greenhouses in the vicinity. The largest of the Cambridge specimens measured 300 mm. in length, with a diameter of 4 mm., shorter individuals measuring from 15 mm. upward with the same diameter of 4 mm. The smallest of the specimens always lack the semilunar head end, they being without doubt, the products of reproduction by transverse division in which the head end had not yet regenerated.

In 1892 Sharp[2] published the description of a Bipalium from a greenhouse in Landsdown, Pennsylvania, which he called *B. manubriatum.* It was suggested by Colin[3] that Sharp's specimen was nothing else than *B. kewense,* for with the exception of the statement that the median stripe is the broadest of the longitudinal markings, the descriptions of *B. manubriatum* agrees in every way with that of *B. kewense.* Variations in the width of the median band in different regions of the same individual of *B. kewense* have been described and figured by Richter[4] and Bergendal,[5] and Dendy[6] has shown the great variability of land planarians within a single species both as regards color and markings. There can be little doubt, therefore, that the single specimen studied by Sharp was the *Bipalium kewense* of Moseley.

The writer would be grateful for any information as to the occurrence of the species in other parts of the United States, and would be glad to have material from other localities.

[2] Sharp, B. On a probable New Species of Bipalium. Proc. Acad. Nat. Sci. Philad., 1891, pp. 120–123, 1892.

[3] Colin, A. Mittheilungen über Würmer. Sitzungsb. Gesell. naturf. Freunde Berlin, Jahrg. 1892, No. 9, pp. 164–166.

[4] Richter, F. *Bipalium kewense* Moseley eine Landplanarie des Palmenhauses zu Frankfurt, A. M. Zool. Garten, Jahrg , XVIII, pp. 231–234, 1887.

[5] Bergendal, D. Studien über Turbellarien. I. Ueber die Vermehrung durch Quertheilung des Bipalium Kewense Moseley. Kongl. Svenska. Vetensk-Akad. Handl., Bd. XXV, No. 4, 42, pp. 1 Pl., 1892.

[6] Dendy, A. Notes on Some New and Little-known Land planarians from Tasmania and South Australia. Proc. Roy. Soc. Victoria, Vol. VI, pp. 178–188, Pl. X, 1893.

2. On the Identity of Procotyla fluviatilis Leidy and Dendrocœlum lacteum Oersted.

Procotyla fluviatilis was first described by Leidy[7] in 1852 under the name of *Dendrocœlum superbum* Girard. In Stimpson's Prodromus[8] (1858) we find for the first time the form under *Procotyla fluviatilis* Leidy M S. with the synonym *Dendrocœlum superbum* Leidy (non Girard). Stimpson's nomenclature evidently being taken from manuscript notes of Leidy, but Leidy himself did not use the name *Procotyla fluviatilis* until 1885.[9] In 1893 Girard[10] in an exhaustive paper on North American Turbellaria makes a new species out of Leidy's first description, which was not his (Girard's) *D. superbum*, calling it Procotyla Leidy (with the synonym *Dendrocœlum superbum* Leidy (non Girard), and also retains *P. fluviatilis* as a second species of Procotyla. In other words, Girard in the same work under two different names gives two different descriptions of the same species. He thus adds greatly to the confusion existing in our knowledge of North American Turbellaria. When our Turbellaria become better known there is reason to believe that the existing large list of species will be much reduced.

A careful study of the structure of *Procotyla fluviatilis* has convinced the writer that this, one of the commonest of our freshwater planarians, is identical with the widely distributed *Dendrocœlum lacteum* Oersted of Europe, and that the genus Procotyla should be abandoned. It was predicted by Hallez[11] that Procotyla would be eliminated when its internal structure should become known. The anatomy and histology of *Dendrocœlum lacteum* has been most carefully worked out by Iijima.[12] His account and figures agree in every way with the American form, as does also the older account of Oscar Schmidt.[13] The variation in

[7] Leidy, J. Corrections and Additions to former Papers on Helminthology. Proc. Acad. Nat. Sci. Philad., Vol. V, pp. 288–289, 1852.

name of *Dendrocœlum superbum* Girard. In Stimpson's[8] Prodromus

[8] Proc. Acad. Nat. Sci. Philad., Vol. IX, pp. 23, 1857.

[9] Leidy, J. Planarians. The Museum, Vol. I, No. 4, p. 5. Philadelphia, 1885.

[10] Girard, Ch. Recherches sur les Planariés et les Némertiens du l'Amérique du Nord. Ann. Sci. Nat., Zool. Tom., XV, pp. 164–166, 1893.

[11] Hallez, P. Catalogue des Turbellariés (Rhabdocœlides, Triclades et Polyclades) du Nord de le France, etc. Revue Biol. du Noru de la France, T. IV No. 11, p. 454, 1892.

[12] Iijima, I. Untersuchungen über den Bau und die Entwickelungeschichte der Süsswasser-Dendrocœlen (Trichleden). Zeitschr. wiss. Zool., Bd. XL, pp. 359-464, Taf. XX-XXIII, 1884.

[13] Schmidt, O. Unterschungen über Turbellarien von Corfu und Cephalonia, Zeitschr. wiss. Zool. Bd. XI, pp. 1–30, Taf. I--IV, 1862.

the number of the eyes in the American form appears to be peculiar, as no mention is made of it in any of the foreign descriptions. In about thirty per cent. of the individuals there are more than the normal number (two) of eyes, the number varying from three to eight, three being the number most frequently occuring.

A detailed account of this and other American Turbellaria, based upon collections made by the Illinois State Natural History Survey and submitted to the writer for study, is in course of preparation.—W. McM. Woodworth.

On the Genus Callisaurus.—Two new species of this genus present lateral fringes of the toes. These are not so well developed as in the species referred to Uma, but they are sufficiently so to show that the latter name must be abandoned, and the species referred to it be placed in Callisaurus. Thus, *Uma notata* Baird, *U. scoparia* Cope, *U. rufopunctata* Cope, etc., must be called *Callisaurus notatus*, etc. The two new species referred to are both from lower California.

Callisaurus crinitus—*Callisaurus dracontoides* Cope, Proceeds. U. S. Natl. Museum, 1889, p. 147. Two series of frontal scales, separated from the rather larger supraoculars by two (or one) rows of small scales. Large supraoculars in four or five longitudinal rows, the inner row largest, the patch bounded by granular scales anteriorly and posteriorly. Interparietal plate longer than wide. Hind leg reaching to front of orbit. Second, third and fourth fingers with well-developed fringes, which are weak on the inner side of the second and third. External side of second, third and fourth toes with well-developed fringes. Femoral pores twenty-three, the scales which they perforate in contact with each other. Color above as in *C. draconoides*. Below a blue patch on each side, with three large oblique black spots and a trace of a fourth. Total length 200 mm., head and body 87 mm., hind leg 72 mm. U. S. N. M., No. 14,895, one specimen.

The differences from *C. draconoides* are the digital fringes, the larger number of femoral pores on adjacent scales, and the three or four black spots of the belly patch; the shorter hind legs, and the longer, interparietal plate. This species has the larger size of the form *C. draconoides ventralis.*

Callisaurus rhodostictus—One row of frontal scales separated by small scales from the rather obscure patch of supraoculars. Interparietal as wide as long. Gular scales subequal. The hind leg extended, reaches to and beyond the end of the muzzle. Well developed fringes on the external sides of the fingers and toes, excepting on the

first and fifth. Femoral pores fifteen and sixteen, in scales which are separated by intervening scales. Coloration above as in *C. draconoides;* below a blue patch on each side which is crossed by three oblique black spots, the third generally followed by a fourth black spot, which does not reach the abdominal border. In front of the blue patch and posterior to the axilla a large rosy spot. A large rosy spot on the gular region. Size smaller, equal the *C. draconoides draconoides.* Numerous specimens from lower California from A. W. Anthony. As this species was accompanied by *Uta parviscutata* V. den B. and *Crotalus ruber* Cope, the locality is not the Cape San Lucas country. It approaches nearer the *C. draconoides* than does the *C. crinitus.* The differences are, the digital fringes, the three or four black abdominal spots, and the rose spots on the sides and throat.—E. D. COPE.

The Food of Birds.—A report upon the food habits of the catbird (*Galeoscoptes carolinensis*) the brown thrasher (*Harporhyncus rufus*) the mocking bird *Mimus polyglottus*) and the house wren (*Troglodytes aëdon*) by S. D. Judd, contains the following information. The wren is exclusively insectivorus, and, therefore highly beneficial to agriculture. Among the pests destroyed by this bird are the snout beetles, of which the plum curculio is a familiar example. Stink bugs and caterpillars, both of which are plant feeders, are also made way with in large numbers. The catbird and thrasher do much less good than the wren because of their mixed diet of animal and vegetable food, the proportion of the former in the thrasher being 63 per cent., that in the catbird 44, for the entire season. The number of mocking birds examined was only 15, so that their character, as friend or foe of the agriculturist, is still undetermined. The stomachs of those examined, however, indicate that the bulk of their food is animal.

Mr. Judd concludes his report by advising farmers to secure the services of the wren by putting up nesting boxes for them, and protecting them from the quarrelsome English sparrows.

A second interesting paper on the food habits of birds records the results of the examination by Mr. F. E. L. Beal of the stomachs of 238 meadow larks, and 113 Baltimore orioles. The meadow lark is a ground feeder and the great bulk of its food is grasshoppers, of which it consumes an enormous number. The other insects eaten are ants, bugs, caterpillars and beetle larvæ.

The oriole feeds largely on caterpillars and wasps, eating so many of the former that it is a highly important beneficial factor in agricultural work.

A summary of the stomach contents for the whole year shows that nearly three-fourths of the food of the meadow lark for the year, including the winter mouths, consists of insects.

The oriole has a similarly good record. The food for the whole season consisted of 83.4 per cent. of animal matter and 16.6 per cent. of vegetable matter.

These statistics show the importance of according these birds the protection they so well deserve. (Year book Dept. Agri. for 1895. Washington, 1896.

Preliminary Description of a New Vole from Labrador.—In the summer of 1895, Mr. C. H. Goldthwaite made a trip to Hamilton Inlet, Labrador, to collect mammals for the Bangs Collection. The material he got is of much interest, but as I am obliged to delay publishing a full account of it for the present, I take this opportunity of making known apparently the only new species he took—a rather remarkable vole.

MICROTUS EXIXUS sp. nov.

Eighty specimens, all taken in the immediate vicinity of Hamilton Inlet.

Type from Hamilton Inlet, Labrador.

No. 3973, ♀, old adult; collection of E. A. and O. Bangs; collected July 15, 1895, by C. H. Goldthwaite. Total length, 210; tail vertebræ, ·67; hind-foot, 22·5.

General characters: Size medium (about that of *M. pennsylvanicus*); tail long; hind-foot large and strong; colors dark with a sooty brown cast to upper parts; skull differing in many minor particulars from that of any eastern vole; molar teeth extremely small and weak, the tooth row very short; incisor teeth long and projecting.

Color: Upper parts a dark burnt umber brown, with many black-tipped hairs intermixed, and a general sooty cast; nose patch the same. Underparts dark gray (some specimens in fresh pelage slightly washed with buffy). Feet and hands dusky. Tail indistinctly bicolored, black above, dark gray beneath.

Cranial characters: Skull rather small (smaller than the skulls of examples of *M. pennsylvanicus*, the external measurements being substantially) the same; rostrum slender and straight; audital bullæ of moderate size, very round; palate without so pronounced a "step" as that of *pennsylvanicus*. Incisor teeth, both upper and under, long, slender and projecting outward at a decided angle. Molar teeth very weak and small, the tooth row averaging 1 m. shorter than in skulls of

pennsylvanicus of equal size; posterior loop of last upper molar extremely small, enamel folding otherwise much as in *pennsylvanicus*.

Size: Average measurements of ten old adult topotypes—total length 189·4; tail vertebræ, 60·4; hind-foot, 22·4.—OUTRAM BANGS.

Zoological News.—CŒLENTERATA.—Mr. Whiteaves records the finding of a second specimen of the branching Alcyonarian coral, *Primnoa reseda*, in the Pacific waters, off the coast of British Columbia. This is the third species of large Alcyonaria now known to occur in this region, viz., *Verrillia blakei* Stearns, *Paragorgia pacifica* Verrill and *Primnoa reseda* Pallas. Fine examples of each of these are in the Museum of the Geological Survey of Canada. (Trans. Roy. Soc. Canada, Vol. I, 1895–'96.)

PISCES.—A new genus (Apogonops) of fishes from Maronba Bay, New South Wales, is described by Mr. J. D. Ogilby. The genus is founded on a single specimen to which has been given the species name, *anomalus*. At first glance this genus appears to belong with the Apogonidæ, but the absence of vomerine teeth and the number of dorsal spines preclude such a classification. (Proceeds. Linn. Soc. New South Wales, 1896.)

REPTILIA.—Dr. Alfredo Dugés has recently published in La Naturaleza, a useful list of the Batrachia and Reptilia of Mexico, with the localities in which they have been found. While a good many species are omitted, the lists of localities are of much value to the student of geographical distribution.

AVES.—From personal observation M. X. Raspail finds that the time occupied by the Magpie (*Pica caudata*) in the incubation of its eggs is from 17 days to 18 days and 13 hours. The young come from the egg entirely bare, without even a trace of down, and are cared for by the parents about 25 or 26 days before they attempt to leave the nest. (Bull. Soc. Zool. de France, Juillet, 1896.)

The birds collected by Dr. A. Donaldson Smith in Somaliland contain a number of species and genera which find their closest allies in the Cape fauna. In a notice of the collection, Dr. Bowdler-Sharpe states that they are more nearly related to the birds of the Cape than to the fauna of Abyssinia or East Africa. (Geol. Journ. Sept., 1896.)

The collection of birds made by Mr. Abbott in Central Asia has been presented to the National Museum. It numbers 210 specimens, representing 97 known species, and one new to science. The collection has been catalogued by Mr. C. W. Richmond, who embodies in his paper a number of interesting notes on many of the species. (Proceeds. U. S. Natl. Mus., Vol. XVIII, 1896.)

MAMMALIA.—Dr. C. H. Merriam has recently revised the Lemmings of the genus Synaptomys, giving descriptions of three new species. He finds that this genus instead of being monotypic, comprises two well marked subgeneric groups—Synaptomys' proper and Mictomys; that the first of these groups inhabits eastern Canada and northeastern United States from Minnesota to New Brunswick, and contains four fairly well defined forms; that Mictomys has a transcontinental distribution from Labrador to Alaska, and contains at least four species. (Proceeds. Biol. Sc., Washington, Vol. X, 1896.)

ENTOMOLOGY.[1]

A New Era in the Study of Diptera.—The work done on the classification of North American Diptera falls naturally into three periods. The first ended with the publication of the "Catalogue of North American Diptera," by Osten Sacken, in 1859. The descriptive work of most value previous to this time was by Wiedmann and Say, and a little by Loew toward the last. Harris, Macquart and Walker had also published numerous species; but there had been little coöperation, and it was nearly impossible to determine from the descriptions the synonyms that had been created. Osten Sacken recognized this condition, and did not attempt to solve such problems in his catalogue.

The following nineteen years to the second edition of the catalogue in 1878 comprise the second period, characterized by the singular fact that the vast amount of work accomplished was almost wholly by Europeans. Walsh published some twenty species, Riley eight, and several others from one to four each—scarce forty in all—while Loew had in the same time performed the monumental work of describing at least 1300 North American species, Osten Sacken had added several hundred, and Schiner and Thomson a considerable number. Moreover, the new edition of the catalogue was enriched with a vast fund of information gathered by the author in the study of American types in all the principal European collections, revising the synonymy and correcting the generic references as would have been impossible in any other way. About the time of the issuance of the catalogue, the collections of Loew and Osten Sacken were deposited in the Museum of Comparative Zoology, at Cambridge, Mass. This marked the conclusion of what may well be called the Loew-Osten Sacken period. Loew died, and Osten Sacken retiring from the diplomatic service, resumed his residence in Germany. His dipterological writings since

[1] Edited by Clarence M. Weed, New Hampshire College, Durham, N. H.

1878, while very important, include only one work which describes new North American species—Vol. I of the Diptera in Biologia Centrali-Americana.

In 1879 appeared the first paper of S. W. Williston, inaugurating a new American period, which has continued to the present time. After a few years D. W. Coquillet began to publish, followed by C. H. Tyler Townsend, and he by others, until the number of those who publish occasional papers is now ten or more.

The recent appearance of Dr. Williston's Manual of North American Diptera[2] gives reason to hope that the immediate future will greatly increase the number of workers in this order, so that we will be justified in counting a new era from 1896. It is now possible to determine the genera of nearly all the flies of North America, including the West Indies, with no other work of reference than this volume. More than Cresson's Synopsis does for the Hymenoptera, or Leconte and Harris' volume does for the Coleoptera, this book does for the Diptera, because it includes the territory southward to the Isthmus of Panama. Only the Tachinidæ and Dexiidæ are not tabulated and analytically reduced to genera, and in this confused mass a bibliographical generic list is given, extending to 272 numbers.

While the book purports to be a second edition of the small one published by the same author in 1888, it is practically a new work, having been entirely rewritten, greatly enlarged, and extended to include the entire order with the exception noted. The bibliography since 1878 is given, and all genera not found in Osten Sacken's catalogue have references (in the index) to their descriptions.

The external anatomy of Diptera is very fully treated. Dr. J. B. Smith's interpretation of the mouth parts is given in addition to the usual one, the author not assuming to decide between them. Professor J. H. Comstock's system of wing nomenclature, as used in his manual, is given a place for comparison, but is not used in the work "for two reasons: First, that it has not yet been fully crystallized into permanent shape; second, because nearly all the existing literature has the nomenclature here employed, and to use a new one would largely defeat the object of the work in the hands of the beginner." Baron Osten Sacken's system of bristle-naming or chætotaxy is quite fully set forth. Each family table is preceded by a full exposition of the family characters and a description of the larva, its mode of life, food, etc. (where known).

[2] Manual of North American Diptera. By Samuel W. Williston, M. D., Ph. D. Pp. LIV, 167. James T. Hathaway, New Haven, Conn., 297 Crown St. Paper, $2.00; cloth, $2.25.

The family known heretofore as Blepharoceridæ appears as Liponeuridæ. This change of name was made by Osten Sacken several years ago. He has more recently abandoned the change in a published paper, and there seems no reason why the old name should be displaced.

The families Xylophagidæ and Cœnomyidæ are united with Leptidæ, thus simplifying the family and generic diagnoses. This seems a rather surprising arrangement, yet may be logically defended.

The family Lonchæidæ is united with the Sapromyzidæ. Aside from these changes there are no important differences in the higher categories between the last catalogue and the present work.

While the printing and binding are excellent, there are a number of typographical errors especially in the spelling of generic names, as for instance in Subulomyia, p. 43, the list of lepidopterous genera on p. 146 (five mistakes) and the list of Tachinid and Dexiid genera, p. 147 (four mistakes). But few of these, however, are more than the interchanging or omission of a letter.

This book is Dr. Williston's most important single contribution to dipterology thus far, and it worthily exhibits the industry, experience and ability of the author, which have secured for him world-wide recognition as a dipterist of the highest rank.—J. M. ALDRICH, Moscow, Idaho.

Color Variation of a Beetle.—Mr. W. Baterson gives an account of his statistical examination of the color variations of the beetle *Gonioctena variabilis*, which appears to be abundant in hilly places in the south of Spain. He finds that we have here to do with a species whose members exhibit variation in several different respects, and that the variations occur in such a way that the individuals must be conceived as grouped round several special typical forms. There is thus not one normal for the species but several, though all live in the same localities under the same conditions, and though they breed freely all together these various forms are commoner than the intermediates between them. Some time since, when calling attention to the excessive variability of the color of *Coccinella decempunctata* and the no less striking constancy of *C. septempunctata* which lives with it, Mr. Bateson remarked that to ask us to believe that the color of the one is constant, because it matters to the animal, and that the other is variable because it does not matter, is to ask us to abrogate reason. Mr. Wallace, it seems, is of this very opinion; but he does not explain how it is that the color of one is so important, and the color of the other unimportant to the beetle. (Journal Royal Microscopical Society.)

American Nematinæ.—The third of the technical series of bulletins from the U. S. Division of Entomology is entitled "Revision of the Nematinæ of North America, a Subfamily of Leaf-feeding Hymenoptera of the Family Tenthredinidæ." It is by Mr. C. L. Marlatt, and extends over 135 pages, with one excellent plate and several illustrations in the text. We quote from the introduction as follows:

"The subfamily *Nematinæ* of Thompson or *Nematina* of Cameron (Konow's subtribe *Nematides*) comprises a very large group of closely allied species, distributed in the classification adopted by the author among nearly a score of genera. They range from very small insects to medium sized, but include no very large species, or in length from 2 to 12 mm. They are for the most part smooth, shining, and rather soft bodied, and are variously colored, but yet presenting frequently a confusing similarity in general form, and particularly in coloration, rendering their generic and specific references in some cases difficult. In point of number of species and abundance of individuals this subfamily far exceeds any other of the corresponding groups in the family Tenthredinidæ, and in variation and peculiarities in larval habits and in economic importance many of the species belonging to it have a very great interest.

"*Geographical Distribution.*—The Nematinæ are distinctly northern in their range, reaching their greatest development in abundance of species and specimens in the transition and boreal zones, and extend northward into the circumpolar regions—species occurring abundantly in Greenland, Iceland, and Spitzbergen. Southward they become less and less numerous, and are particularly wanting in tropical countries. This is illustrated very forcibly in Europe by the occurrence of over 70 species of the old genus *Nematus* in Scotland (Cameron) and 95 in Sweden (Thompson) as against 12 about Naples, Italy (Costa); and the same discrepancy exists between the temperate and subarctic region of America and the Southern States and Mexico.

"*Food-plants.*—Their food-plants cover a wide range, some species affecting grasses, one or two very destructive to the grains, others various deciduous trees and shrubs, and still others conifers. The majority of the species occur, however, on plants of the families Salicaceæ, Betulaceæ, Rosaceæ, and Coniferæ, in the order given.

"*Life history and habits.*—The Nematines are among the first sawflies to appear in spring, occurring abundantly on trees on the first appearance of the leaves. They do not often frequent flowers, except, at least, those of the plants upon which their larvæ feed. Many willow species, for example, occur abundantly on the earliest spring bloom of the

willow. In common with other sawflies, however, they rarely leave their larval food-plants, and to be collected successfully a knowledge of their habits in this respect is very desirable.

"In number of broods great diversity is found, and the normal rule of most Tenthredinidæ, of a single yearly brood, is frequently deviated from. Some species are known to be limited in number of broods only by the length of the season, as, for example, *Pteronus ventralis* Say, the common willow species. Two annual generations are common, but many species are single brooded, the larvæ entering the soil or other material or remaining in their galls at the completion of growth and continuing in dormant condition until the following spring, when shortly before they emerge as perfect insects the change to the pupal condition takes place. The males normally appear a few days before the females, and the duration of the life of the adults of both sexes is short, not often exceeding a week or ten days. Of a large percentage of the species no males are known, and in the case of many species careful and repeated breeding records indicate that males are very rarely produced.

"In some species parthenogenesis is complete; that is, the eggs from unimpregnated females produce other females. In other instances of parthenogenesis, however, either males only are developed from unfertilized ova or females very rarely.

"The union of the sexes takes place very shortly after the appearance of the females, and egg deposition closely follows. The eggs are inserted either singly or a number together in the young twigs, larger veins, petioles, in the surface parenchyma, or in the edges of the leaves, the single exception being the case of the gooseberry sawfly (*Pteronus ribesii*), which merely glues its eggs to the leaf without making any incision whatever.

"Most of the species are external feeders on the foliage of plants, but the species of two genera, *Euura* and *Pontania*, so far as their habits have been studied, are gall makers, and pass their early life in the interior of the plants, either in the stems without causing abnormal growths or in the excrescences or galls on the stems and leaves. At least one American species develops in the rolled or folded edges of the leaf. The larvæ are 20-footed, some solitary, others gregarious—the latter usually more brightly colored and possessing means of protection in glands secreting a noxious fluid. Most of the solitary ones are green and not readily observed. They usually feed from the underside of the leaves, eating from the edge or cutting circular holes in the general surface, and in some cases taking everything but the stronger veins. Many species rest quietly during the day, feeding only at night.

Some have the habit of throwing the posterior segments violently upward to frighten away parasites or enemies; others adhere to the leaves or twigs by the thoracic feet only, coiling the posterior segments under the middle ones."

Entomological Notes.—Prof. F. L. Harvey monographs in an elaborate manner the Currant Fly, *Epochra canadensis*, in the report of the Maine Experiment Station.

The North American species of Nemobius are monographed by Mr. S. H. Scudder (Journ. N. Y. Ent. Soc., Sept., 1896). Several new species are described.

Mr. Alex. D. MacGillivray has recently monographed the American species of Isotoma in the Canadian Entomologist

In the check-list of the Coccidæ published by Prof. T. D. A. Cockerell, in the Bulletin of the Illinois State Laboratory of Natural History (vol. IV, pp. 318–339) 773 species are listed.

A number of new species of Scarabeidæ are described by Martin L. Linell in the Proceedings U. S. National Museum (vol. XVIII, pp. 721–731.

Prof. J. B. Smith discusses again the San José Scale (*Aspidiotus perniciosus*) in Bulletin 116 of the New Jersey Station.

"The Principal Household Insects of the United Stated" is the title of the extremely valuable and interesting Bulletin No. 4 of the Division of Entomology, U. S. Dept. of Agriculture. It was prepared by Messrs. Howard, Marlatt and Chittenden.

The Lamiinæ of North America are monographed by Messrs. C. W. Leng and John Hamilton, in the Transactions of the American Entomological Society (vol. XXIII, No. 2). In the same issue Mr. William H. Ashmead describes a large number of new parasitic Hymenoptera.

Mr. F. M. Webster discusses the Chench Bug in Bulletin 69 of the Ohio Experiment Station, and several destructive insects in Bulletin 68.

The Phylogeny of the Hymenoptera has recently been discussed by Mr. Ashmead in an interesting and authoritative paper in the Proceedings of the Entomological Society of Washington (vol. III, No. 5).

EMBRYOLOGY.[1]

Movements of Blastomeres.—In a copiously illustrated and extensive paper on the cleavage of *Ascaris megalocephala* Otto zur Strassen[2] lays special emphasis upon certain movements of the cells of the embryo.

In the living egg most remarkable rearrangements of the material are easily seen when the first four cells glide over one another. In later stages changes in form are traced to movements of the cells that must have taken place though not actually seen but inferred from a very detailed study of preserved material. The author confined his attention chiefly to the ectodermal layer of cells and knowing the pedigree of a very large number of them was able to affirm that the changes in shape that the embryo exhibits are due, in part at least, to an actual migration or rearrangement of cells. Cell division and surface tension are not the only factors concerned in this change of position of the cells; there must be some individual movement of certain cells.

This movement of the cells is regarded as being of the same nature as that observed by Roux in the isolated cells of the frog's egg and is, therefore, designated *Cytotropism.*

The production of form in the development of the Ascaris embryo has then this important factor—a power of cells to move towards one another and thus change the shape of the entire mass. This movement is in addition to any purely mechanical movements due to surface tension and is due either to attraction between cells or to repulsion between cells. In either case it is assumed that chemical influences are at work: that this movement arises from *chemotactic* strains.

The movements are much restricted in that a cell travels its own length at most and is never free from its sister-cell. In fact the two cells that arise from the division of one remain connected and are not to be separated by any intrusion of migrating cells and the author thinks that the movements are probably even more restricted in being merely the rearrangements of two groups of such sister-cells both derived from one parent, being merely readjustments of four grandchildren of one cell! The entire ectoderm may then be regarded as a mosaic of such sets of families of four, each having its own internal readjustments.

[1] Edited by E. A. Andrews, Baltimore, Md., to whom abstracts reviews and preliminary notes may be sent.

[2] Archiv f. Entwickelungsmechanik, 3, 1896, pps. 27–101, 133–188, Pls. V–IX.

Moving pigment in Eggs.—In a carefully illustrated account[3] of the cleavage of the Planarian, *Polychœrus caudatus* Mark, Dr. E. G. Gardiner describes most remarkable changes in position of peculiar, algalike, pigment bodies which color the eggs orange-red for a certain period. These bodies appear in certain cells and then others, they lie along the lines where cleavage is to take place.

They move up from the centre of the egg to the surface and move from place to place.

Fertilization.—By the use of nitric acid Kostanecki and Wierzejski find that the so-called achromatic substance may be demonstrated with remarkable clearness in the eggs of the pond snail *Physa fontinalis*. In a detailed description[4] of radiations, or stars, of this substance seen during the process of maturation of the egg and during fertilization, illustrated by many remarkable figures of reconstructed sections, the authors give the facts that lead them toward the following hypothetical conception of the true nature of the process of fertilization.

The object of fertilization is the union of the nuclei; but the necessary condition to make this of avail is that the egg be able to continue to divide, to undergo cleavage. This power is brought to it by the new nuclear part of the sperm.

Each sexual cell needs to be supplemented by what the other has and it itself is deficient in. This lack is in the protoplasm.

The egg has large amounts of nutritive material while the sperm has none. The former has thus relatively too little protoplasm to continue dividing by itself. During maturation, by dividing twice to form polar bodies, the egg uses up its remaining power of division and must have this added to it again if it is to cleave at all.

What the sperm brings in to replace the exhausted cleaving powers of the egg is the connecting piece of the sperm, the portion near the head or nucleus, that contains achromatic material centered on the centrosome or speck next the head. This material is the remnant from the achromatic figure of the last cell division in the formation of sperms.

This material is conceived of as concentrated and not, as yet, recognized till it gets into the egg; then it swells up and extend in radii as an umbrella unfolds. As the sperm revolves through 180° after entering the egg the middle piece preceeds the sperm head or male nucleus in its journey towards the female nucleus. The middle piece appears as a star centered about the centrosome and rapidly grows in all direction

[3] Journal of Morphology, XI, pp. 155–171.

[4] Archiv. f. Mik. Anat., 47, 2, Apl, 1896, pps. 309--379, Pls. 18--20.

by "assimilating" the net-work of the egg. Thus the star, so remarkably distinct in these snail eggs, about the centrosome of the sperm is to be regarded as at first of male origin and then as gradually getting control of the net-work protoplasm, or the archoplasm, of the egg so that it is eventually the centre of an entire rearrangement of this egg material focussed about the male centrosome.

The centrosome next the famale nucleus disappears and the star about it is "assimilated" by the star that arose about the male nucleus. Sooner or later the male star and centrosome divide to furnish the two-centered system concerned with division of the cleavage nucleus. The male and female nuclei unite to make the cleavage nucleus and the two protoplasmic stars do all that remain to be done in the subsequent cleavage.

The substitution of the new male system for the effete female system of radiate protoplasm is regarded as so complete that the chromosomes in the female nucleus become subjected to the domination of the male system by the growing male radii attaching themselves to these chromo somes by a process of "assimilation" of the old connections, that the author believes to exist between the female chromosomes and the female centrosomes. It is assumed that this male system is all along connected with the chromosomes of the sperm head and that the contractoin of the radii draw the sperm head toward the female nucleus.

Along with the reduction of the chromosomes in both egg and sperm there is probably a reduction in the mass of so-called achromatic substance so that in fertilization there may well be restitution of the normal amount by a mutual supplying of the deficiency.

It will be seen that this conception of the process of fertilization is that of Boveri except that the centrosome is regarded as of no importance and the surrounding, radiated protoplasm becomes the essential factor for cell division. The authors follow Heidenhain in regarding the centrosome as merely the point of insertion of that active, contractile part of the cell that radiates out from this centre.

PSYCHOLOGY.[1]

The Effects of Loss of Sleep.—Prof. Patrick and Dr. Gilbert, of the University of Iowa, have reported in the *Psychological Review* some experiments on this problem. Three normal subjects were kept awake for a period of ninety nours, without resort to stimulants or other

[1] Edited by H. C. Warren, Princeton University, Princeton, N. J.

physiological means. During the four days and three nights of the test they were engaged, as far as possible, in their usual occupations; their meals were of the customary kind, and were taken at the ordinary times, with the addition of a light lunch at about midnight. At intervals of six hours a series of tests was made on each subject, to determine his mental and physical condition. To eliminate the effects of practice, these tests were begun three days before the experiment. The test of the first day of experiment, before any loss of sleep had actually occurred, represent the normal condition of the subject. Tests were also made after the night's sleep that followed the conclusion of the experiment. One of the writers was the first subject. The two other subjects were instructors in the university; the latter were experimented upon at the same time.

Some of the results are of special interest. The reaction time (for sound) showed a gradual increase for two of the subjects, which was masked in the third case by increase of practice; at one period (different in the three cases) the time was considerably greater than earlier or later in the experiment; the mean variation was somewhat above the normal, but not remarkably great. The acuteness of vision, measured by the distance at which a page of print could be distinguished and read, actually increased during the progress of the experiment, and fell off again after the ensuing sleep. The memory test of the two last subjects consisted in committing random series of figures; the time required for this memorizing fluctuated considerably, with a marked lengthening towards the close of the experiment. One of the subjects was unable to memorize the figures at all at two of the last day's tests; he found it impossible to hold the attention upon the task long enough to complete it. The time consumed in adding sets of figures was fairly constant, with two or three exceptions; it was apparently independent of the memory conditions. "Voluntary motor ability," tested by the number of taps that could be made with the finger in five seconds, showed no marked alterations; neither did the susceptibility to fatigue, as tested by continuing this tapping for sixty seconds. The strength of grip, measured on the squeeze dynamometer, fell off from 20 to 30 per cent. at the end of the second day, but afterwards recovered—in two cases fully, in the other partially. The weight of the men remained fairly constant, showing a slight increase towards the close of the period, and the variation of the pulse was within the normal range of daily fluctuations.

The first subject suffered from marked visual hallucinations after the second night. "The subject complained that the floor was covered with

a greasy-looking, molecular layer of rapidly moving or oscillating particles. Often this layer was a foot above the floor and parallel with it, and caused the subject trouble in walking, as he would try to step up on it. Later the air was full of these dancing particles, which developed into swarms of little bodies like gnats, but colored red, purple or black. The subject would climb upon a chair to brush them from about the gas jet, or stealthily try to touch an imaginary fly on the table with his finger. These phenomena did not move with movements of the eye and appeared to be true hallucinations, centrally caused, but due no doubt to the long and unusual strain put upon the eyes. Meanwhile the subject's sharpness of vision was not impaired. At no other time has he had hallucinations of sight, and they entirely disappeared after sleep." Neither of the other subjects experienced these hallucinations.

At the close of the experiment the subjects were allowed to sleep as long as they desired. Tests were made upon the first subject, however, at hourly intervals during the first night, to determine the depth of his sleep. He awoke naturally after ten and a half hours, and remained awake during the rest of the day, but slept two hours more than his normal amount the second night. Of the other subjects, one awoke of his own accord after eleven, the other after fourteen hours' sleep; both felt quite refreshed; they required no extra sleep the next night, and felt no ill effects from the experiment.

It will be noticed that the sleep made up was but a small proportion of the amount lost, viz., 16, 25 and 35 per cent. in the three cases respectively. Two possible explanations for this are offered: either a greater depth of sleep may make up for a lesser duration; or sleep is a relative phenomenon, and the subjects, while apparently awake, were in reality partially asleep at times during the experiment. The authors believe that both of these facts are true, and that they operated together in the present instance. While the subjects were not allowed to go to sleep for an instant, and the slightest tendency to close the eyes was met by active measures, still there were indications of the presence of dreams, in lapses of memory and occasional irrelevant remarks. "It must be understood," say the writers, "that these dreams were instantaneous and the subject as wide awake as he could be kept; but these facts reveal a cerebral condition related to sleep. This hypothesis alone, however, would not seen to account fully for the small proportion of sleep made up. And, indeed, a study of our special tests shows that restoration took place chiefly during the profound sleep following the sleep fast, and took place rapidly. That this sleep was actually more profound, and that the profound part of it was longer than usual, was shown by our experiments in depth of sleep," on one of the subjects.

The authors think it would have been possible to prolong the experiment beyond the ninety hours without danger, except in one of the three cases. These results contrast favorably with those obtained by M. de Manacéine upon young dogs. The animals were kept from sleeping and died at the end of the fourth or fifth day.—H. C. WARREN.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

American Philosophical Society.—November 6, 1896—The following communications were made: "Recent Archæological Explorations on the Shell Keys and Gulf Coast of Florida," by Frank Hamilton Cushing, followed by Dr. D. G. Brinton and Prof. F. W. Putnam.

November 20, 1896.—Prof. H. V. Hilprecht addressed the Society on his recent archæological discoveries at Nippur, and exhibited a collection of tablets with Summerian inscriptions. A paper on "A New Physical Property of the X-Ray," by Charles L. Leonard, M. D., was read.

University of Pennsylvania, BIOLOGICAL CLUB.—November 2, 1896.—The following demonstrations were made; Descriptive Exhibitive of Streptocarpus and Ephedra by Dr. J. M. McFarlane and of Botrychium by H. C. Porter. The following communication was made; School Museums, by Mrs. L. L. W. Wilson.

H. C. PORTER, *Secretary.*

The Biological Society of Washington.—The following communications were made; Theodore Gill, "The Category of Family or Order in Biology;" C. Hart Merriam, "Notes on the Fauna of Oregon;" E. A. DeSchweinitz, "Some Methods of Generating Formaldehyde, and its Use as a Disinfectant;" C. Hart Merriam, "Supplementary Notes on Tropical American Shrews.

November 21st.—The following communications were made: G. H. Hicks, "The 'Mildews' (Erysipheæ) of Michigan;" Frederick V. Coville, "The In florescence of the Juncaceæ;" Theodor Holm, "The Alpine Flora of Pikes Peak and Grays Peak in Colorado;" C. L. Pollard, "Some Further Remarks on Briton and Brown's Illustrated Flora."

FREDERIC A. LUCAS, *Secretary.*

National Academy of Sciences.—A scientific session of the Academy was held in New York, at the Columbia University, beginning November 17, 1896, at 11 o'clock, A. M.

The following papers were read: "On Certain Positive Negative Laws in their Relation to Organic Chemistry," A. Michael; "The Jurassic Formation on the Atlantic Coast," O. C. Marsh; "The Hydrolysis of Acid Amides," Ira Remsen; "The Isomeric Chlorides of Paranitroorthosulphobenzoic Acid," Ira Remsen; "The Equations of the Forces Acting in the Flotation of Disks and Rings of Metal, with Experiments Showing the Floating of Loaded Disks and Rings of Metal on Water and on Other Liquids," Alfred M. Mayer; "On the Geographical Distribution of Batrachia and Reptilia in the Medicolumbian Region," E. D. Cope; "On the Solar Motion as a Gauge of Stellar Distances," S. Newcome; "Memoir of F. B. Meek," C. A. White; "The Evolution and Pylogeny of Gastropod Mollusca," A. E. Verrill; "On Flicker Photometers," O. N. Rood; "A New Type of Telescope Free from Secondary Color," C. S. Hastings; "A Graphical Method of Logic," C. Pearce; "On Mathematical Infinity," C. Pearce.

A reception was given to the Academy by Mrs. Henry Draper, on the evening of Wednesday, November 18.

Boston Society of Natural History.—November 4th.—The following paper was read: Prof. George Lincoln Goodale, "The Reclaiming of Deserts."

November 18th.—The following papers were read: Prof. George H. Barton, "Observations upon the Inland Ice and the Glaciers Proceeding from it in the Umanak District, Greenland;" Prof. Alfred E. Burton, "The Topographical Features of the Umanak District, Greenland. Other members of the Greenland Expedition were present, and took part in the discussion.—SAMUEL HENSHAW, *Secretary.*

The Academy of Science of St. Louis.—At the meeting of November 2, 1896, Mr. Colton Russell spoke of "What an Entomologist Can Find of Interest About St. Louis," illustrating his remarks by numerous pinned specimens of insects, giving particular attention to the butterflies, and speaking at some length of the phenomena of periodicity, migration, polymorphism, etc., as illustrated by these insects, his paper embodying the result of a large amount of field work performed during the last ten years. Resolutions were adopted opposing the passage of the antivivisection bill now before the United States Senate. Three persons were elected to active membership.

At the meeting on the evening of November 16, 1896, Dr. Charles R. Keyes, the State Geologist of Missouri, read a paper entitled, "How Shall We Subdivide the Carboniferous?" and Professor J. H. Kinealy exhibited a chart for determining the number of square feet of low-pressure steam-heating surface required to keep a room at 70° F., and gave a description of the method of making the chart. Two active members and one life-member of the Academy were elected.

William Trelease, *Recording Secretary.*

New York Academy of Sciences.—November 9th.—Members of the Columbia University Expedition to Puget Sound made reports on the summer's work.

Mr. N. R. Harrington gave a short narrative of the expedition, including a description of the equipment of the laboratory, dredging, investigation and plankton collection.

In addition, he made a report on the Echinoderms, Crustacea and Annelids. Mention was made of the relation of the asymmetry in *Scutella excentrica* to its habit of burrowing and its vertical position in the sand. Abundant material, both larval and adult, of *Entoconcha* was obtained. This mollusk had been noted by Müller in 1852, and Baur in 1864, in *Synapta digitata* and by Semper in *Holothuria edulis.* The present material was found in an undetermined species of *Holothuria.* About forty species each of Crustacea, Annelids and Echinoderms have been identified.

Mr. Bradney B. Griffin presented the following report on the Platodes, Nemerteans and Mollusks:

The Platodes and Gephyrea are relatively scarce. They are represented solely by two Dendrocoels, and one Phymosoma respectively. The nemertines occur very abundantly, fully fifteen different species were obtained, most of which appear to be undescribed, though some seem to approach more or less closely the European forms rather than those of the east coast of America. The European species are the more numerous.

The Molluscan fauna is very rich and varied, ninety-three species of sixty-nine genera were collected. These include among others the large *Cryptochiton stellerii* which, when alive and expanded measures over 20 cm., besides numerous smaller species of Mopalia, Katherina, Tonicella, etc., that occur in vast numbers on rocks and piles between tides. The Nudibranchs are notable from their bright colors and large size. One species of *Dendronotus* attains a length of over 25 cm. Cases of color variation (*Cardium* and *Acmaea*) and color series (*Littorina*) were to be met with, as well as color harmonization; many

Chitons and Limpets are colored so as to more or less resemble the speckled and barnacled rocks upon which they occur. A complete series of *Pholadidea penita* (the "boring clam") was obtained, which shows the gradual atrophy of the foot and concrescence of the mantle edges as the adult condition is attained. Specimens of *Zirphæa crispata* were collected, a related form in which the foot remains functional throughout life. A series of maturation and fertilization stages of this form was obtained. *Lepton* is not uncommon, a Lamellibranch that lives with commensal attached by its byssus to the abdomen of the Crustacean *Gebia*, and has caused the atrophy of the first pair of abdominal appendages of its host. It has developed a median furrow on each valve in adaptation to the body form of Gebia. An interesting case was observed in which an otherwise nearly smooth *Placuanomia* shell had assumed during its growth the concentric raised lines of a *Saxidomus* valve upon which it was attached.

The insects are not very abundant, they are represented in the collection mainly by a few wood beetles, myriopods (*Julus, Polydesmus*), and a species of *Termes*.

Mr. Calkins reported on the Protozoa and Coelenterates of Puget Sound and of the Alaskan Bays.

The Protozoa and Coelenterates collected during the summer by Mr. Calkins belong chiefly to the group Flagellata for the former, and to the Leptomedusæ for the latter. In addition, there are nine species of hydroids—a large number, considering the very limited representation of this group in the western waters. Twelve or fourteen species of Actinians and about the same number of sponges, and several Scyphomedusae complete the list of Coelenterates.

Mr. Bashford Dean reported on the Chordates and Protochordates of the Collection. The Ascidians are represented by about a dozen species, Fishes by upwards of forty. The most important part of his work had been the collecting of embryos and larvæ of Chimaera (*Hydrolagus colliei*) and a fairly complete series of embryos of Bdellostoma, including upwards of 20 stages from cleavage to hatching. Of Chimaera, upward of eighty egg cases had been dredged in a single day; but in every case these were found to be empty. The eggs were finally obtained at Pacific Grove, California, from the female, and were incubated in submerged cages. It was in this locality that the eggs of Bdellostoma were collected.

C. L. BRISTOL, *Secretary.*

SCIENTIFIC NEWS.

The Hindshaw Natural History Expedition returned to the University of Washington at Seattle, June 15, 1896 from the eastern part of State. The party consisted of Henry H. Hindshaw, Curator of the Museum, Mrs. Hindshaw, and Trevor C. D. Kincaid, Laboratory Assistant in Biology. Transportation was secured for the members of the expedition from the Northern Pacific Railroad, through Surgeon F. H. Coe of Seattle. The party made headquarters at Pasco, where they proceeded to collect a fine lot of plants not found in other parts of the state. In all there were acquired several hundred specimens, covering 150 species. Arrangements were then made for an exploration for Indian relics up the Snake river; and in the meantime Mr. and Mrs. Hindshaw proceeded to the sand hills of Douglas county. These were reached by a trip to Ritzville, thence to Hatton, and from there a drive to the hills of about sixteen miles. Mr. Hindshaw reports some interesting geological facts concerning these sand-hills, or dunes. By an examination of the surrounding blanket or cover of basalt; he concludes that the area covered by these dunes was left uncovered by the general flow of lava making the basalt. This deposit of sand is the layer known as the "John Day" bed. It is the water-bearing rock of Eastern Washington. Farmers come from miles to these sand-hills, where they get plenty of water with little digging. Away from the dunes artesian wells have been sunk. Water is obtained, but sometimes it is necessary to bore through hundreds of basalt to reach the "John Day," or water-bearing, rock. The "John Day" beds carry most interesting fossil bones. Mr. Hindshaw brought home many teeth and bones of the fossil rhinoceros and horse, the latter probably the three-toed ancestor of the present horse. These bones have been worn in the waves of moving sand as badly or worse than is a shell battered by the waves of the ocean. Only the hardest parts of the bones remain, but these are of great interest until further explorations yield more perfect skeletens of these prehistoric mammal remains. After making a thorough search of these sand-hills and procuring all the fossil bones in sight, the party returned to Pasco. Here Mr. D. A. Owen, an enthusiastic collector of Indian curios, had perfected arrangements for a trip up Snake river to Page's ferry and on to the deserted cattle-ranch known as McCoy's. These places were evidently the camping grounds of great bands or villages of Indians before the arrival of the white

man. Many of the old graves are cut out and washed away by the river, but the expedition succeeded in obtaining many valuable specimens, such as stone mortars, pestles, hammers, skin-scrapers, arrow- and spear-points, all of different sizes and shapes. At one place was found a large stone anvil, around which were many fragments of flint and basalt and half-formed arrow-points, showing the remains of a genuine Indian weapon factory. A number of Indian skulls were also obtained. Mingled with these remains and old stone implements, were old brass buttons, blue beads, and an old iron adz, showing that the time of the making of the graves and caches was about the time of the Hudson Bay Company's occupation of the territory in the early part of this century.

Mr. Kincaid secured about 3,000 specimens of insects, comprising about 300 species, which will make a valuable addition to the University's entomological collections.

Thus far the expenses of these collecting expeditions have been borne by individuals, though the University gets the full benefit of the work, and the entire collections.

Other expeditions are planned for the summer months in the various fields of natural science.